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THE TELEGRAPHIC JOURNAL

AND

ELECTRICAL REVIEW.

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AND
ELECTRICAL REVIEW.

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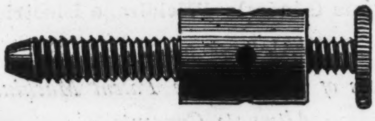

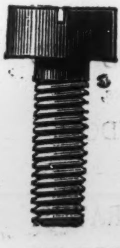

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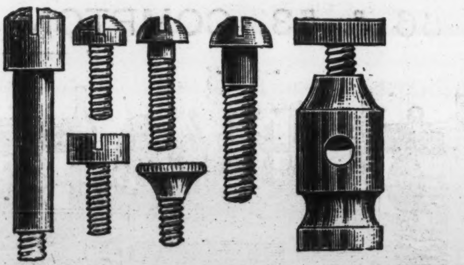

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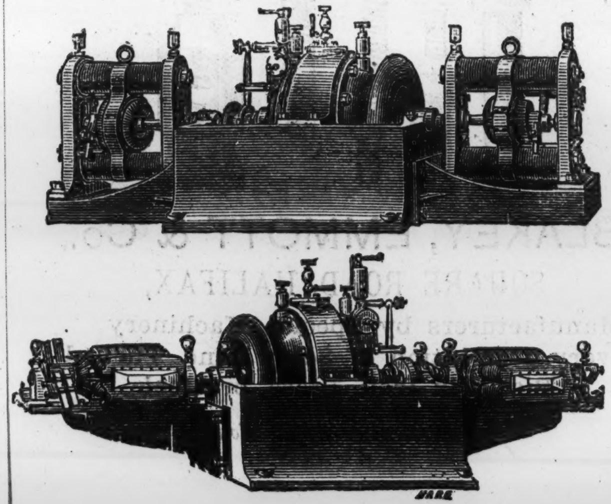

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VOL. IX.—NO. 213.

THE PARIS ELECTRICAL EXHIBITION.

THE BRITISH SECTION.

THE INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY.

TORPEDO APPARATUS.

(*Continued from page* 452.)

"ELECTRO CONTACT SYSTEM." Beyond the three converging lines of torpedoes, shown in fig. 1 (page 449) are three groups of mines to protect the entrance to the harbour; these are fired solely by *circuit-closers* contained in the buoyant torpedoes and actuated, as the name of the system implies, by direct *contact* with the hostile vessel.

Branch cables connect the four torpedoes of each group with the *junction box*, J′, where they are joined, through *disconnectors*, to a single-core cable, reaching to a second junction-box nearer in-shore; here the three main conductors are made up into a multiple cable, communicating with the firing-station on shore. A *signalling and firing instrument*, similar to that already described, is joined up in circuit with each of the three main conductors; this instrument switches in the *firing battery* and indicates the particular group to which an exploded torpedo belongs.

The *circuit-closer* (fig. 5), known as *Mathieson's improved circuit-closer*, consists of a *coiled tapering spring*, which carries a *contact-disc*, D, through the centre of which rises a spindle, surmounted by a brass ball. The *contact-disc* is connected to a platinum wire fuze, and to the cable by a wire, *h*, but is insulated from the spring and spindle by an ebonite ring. The apparatus has three adjustable contact screws, equi-distant from each other, and set opposite to springs, *e*, the latter being connected through the base of the instrument with the metal of the buoy inclosing it, so as to make a tolerably good earth. It is usual to adjust the contact screws so that, when the instrument is held in a horizontal position, they are just short of touching the earth springs. Thus adjusted, the circuit-closer is unaffected by the regular undulating motion of the waves, but should a passing vessel strike the torpedo, the concussion sets the circuit-closer oscillating violently, and repeated contacts are made between the *contact-disc* and the earth springs, thus completing the circuit continually and allowing a current from the firing battery to pass.

The employment of a *coiled tapering spring* secures very much more prolonged contacts than was the case when a steel rod was used, as was formerly the case, and it has enabled Mr. Mathieson to reduce the weight of the ball at the top of the spindle from 2½ lbs. to 9 oz.

Fig. 6 is a vertical section of a buoyant torpedo with the circuit-closer, fuze, and bursting charge complete; it is a pear-shaped buoy, with a wooden jacket streugthened with hoop-iron, and has a galvanised iron lining. The circuit-closer and fuze at K are placed before a bursting charge of 2 lbs. of dry gun cotton at R; and the whole is inclosed in a gun metal shell to exclude moisture. One wire of the fuze is joined to the conductor of the cable which enters the torpedo from below, and the other wire is connected to the *contact-disc* of the circuit-closer. The interior of the torpedo is filled with damp gun cotton.

As a torpedo bursting near a vessel is considerably more destructive when it is in actual contact with the latter, than when it is submerged at a distance below the surface of the water, it is found necessary to employ 500 lbs. of gun cotton in the latter case, while 100 lbs. suffice for surface charges. On the other hand, torpedoes moored as in fig. 9 (page 491) command a wider area and are, on that account, more suited for the *firing by observation system*. They must, however, be moored at a greater distance apart (generally not less than 300 feet) so that the bursting of one torpedo may not explode its neighbour.

The two conductors of the *platinum wire fuze* (fig. 7) pass through an ebonite plug and have their ends tinned and bridged across by a fine platinum wire ·003 inches in diameter and one quarter inch long. Around the platinum wire bridge, inside *b*, is a small quantity of granulated gun cotton, and above it rises a tube, *o*, containing *fulminating mercury*, which is inserted into the bursting charge, R, fig. 6.

When the buoy containing the circuit-closer receives a violent blow, the circuit is closed and the current from the firing station heats the platinum wire, this ignites the granulated gun cotton, fires the fulminating mercury, and explodes the mine.

Since all the mines in the system are fired by the same *signalling battery*, it is evident that when one torpedo is exploded, the battery would be *to earth* through the shattered end of the cable. To obviate this defect, Mathieson's disconnector (fig. 8) is introduced into each of the branch circuits at the junction box, J. It consists of an ebonite plug, *e*, through which pass two india-rubber covered wires, the latter and the ebonite being *cured* together to form a solid, so as to effectually prevent any moisture finding its way along the wires, even under pressure.

The ends of the wires are tinned and bridged across by a fine platinum wire, *b*, ·003 inch in diameter, and about one quarter inch long, as in the case of the platinum wire fuze (fig. 7). Immediately around the *bridge* is a film of gun cotton, and below it and between the copper conducting wires is a tube, *t*, containing a slow fuze. A small cap, *c*, containing granulated gun cotton, is fitted over the platinum wire, and the whole is encased in a cast-iron shell, *g*, the interior of which is made perfectly water-tight by a gutta-percha washer, *w*, placed between the cover and the base to which it is screwed. When the circuit is completed by a vessel striking the circuit-closer, the current from the firing station fires the fuze in the torpedo, and at the same time heats the platinum wire of the disconnector in the junction box, and so fires the granulated gun cotton. This in turn ignites the slow fuze, *t*, which, being very cross grained, mechanically ruptures the platinum wire *bridge* and severs the branch circuit from the system. The cast-iron shell is made sufficiently strong, and has space large enough inside, to admit of the gas, generated by the ignition of the gun cotton, expanding without receiving injury, so that perfect insulation at the break is secured.

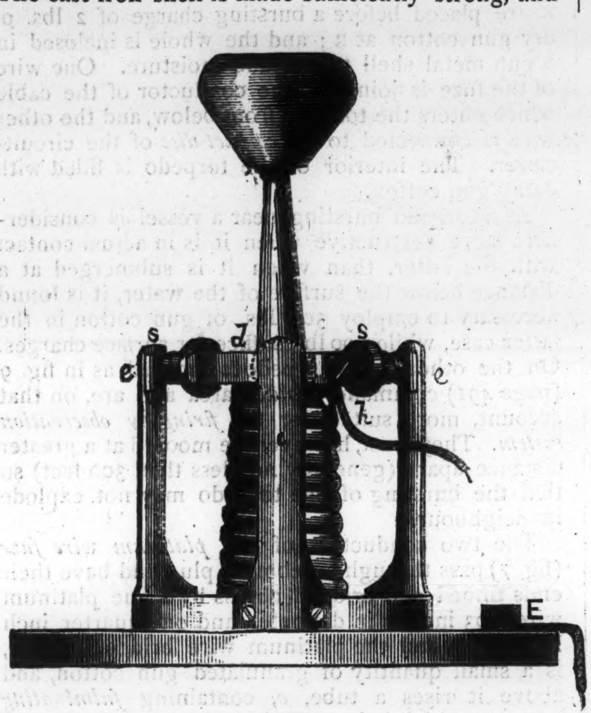

FIG. 5.

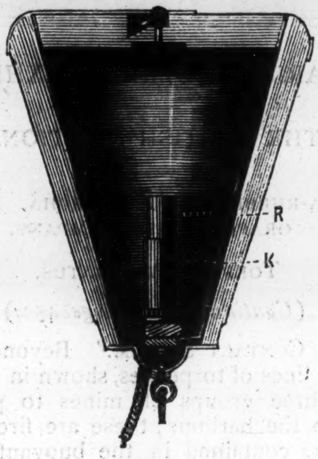

FIG. 6.

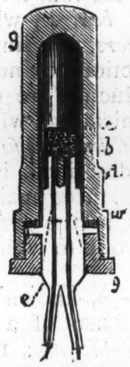

FIG. 8.

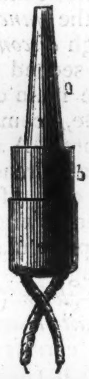

FIG. 7.

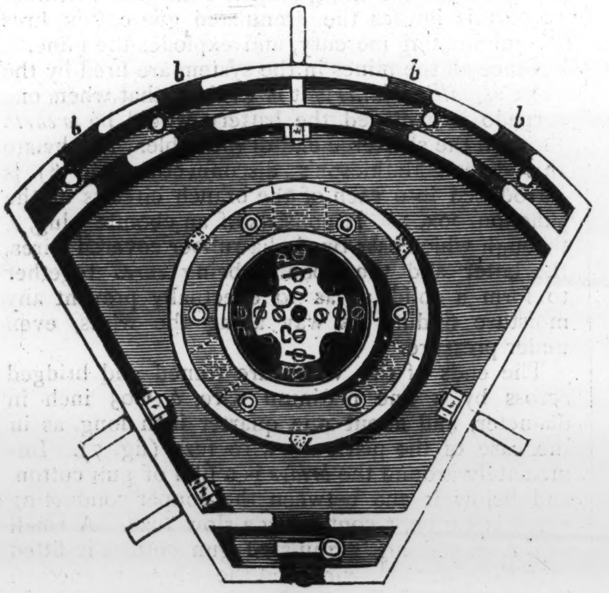

FIG. 11.

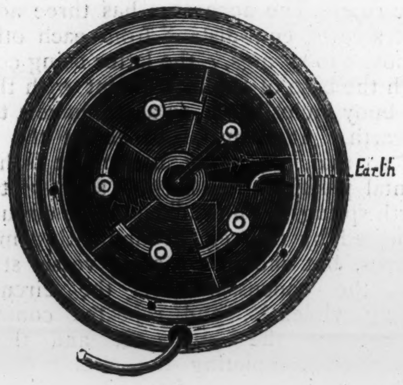

FIG. 12.

It is, of course, essential that the torpedo be exploded before the *disconnector* cuts out the branch circuit; and this is brought about by the slow fuze, *t*, which allows an appreciable time to elapse after the platinum wire *bridge* is heated, before fulfilling its function. Another method of breaking the platinum wire is to insert a wooden pin through the small ebonite cap, *e*, between the copper conductors and below the *bridge*, so that when the cap is forced off by the gas expanding, the pin is carried with it and breaks through the platinum wire. In this case the action of the disconnector is retarded by using a platinum wire of rather larger diameter than that used for the fuze, so that the latter becomes heated first. The importance of some such simple and effectual means of cutting out a circuit is obvious, as without it it would be necessary to employ a separate conductor for each torpedo.

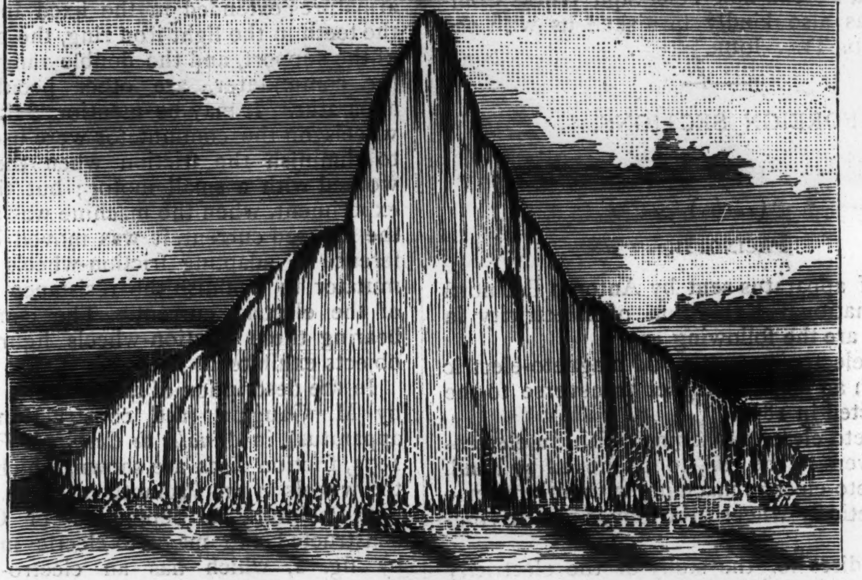

FIG. 13.

Fig. 11 shows the interior of a *junction box* for the *main* cable, C, and four branch cables, *b*. On a small platform inside are holes, into which four *disconnectors*, one for each branch circuit, are fitted; one wire of the disconnector is joined to its branch conductor and the other to a plate, *n*. In the centre is a brass plate, C, to which the main cable is attached, and which overlaps the four plates, *n*, so that it may be connected to them by thumb-screws. Should it become necessary to raise the junction box at any time for testing purposes, this commutator enables the electrical condition of the branch circuits to be ascertained separately, or any one to be disconnected from the main cable by unscrewing the corresponding screw.

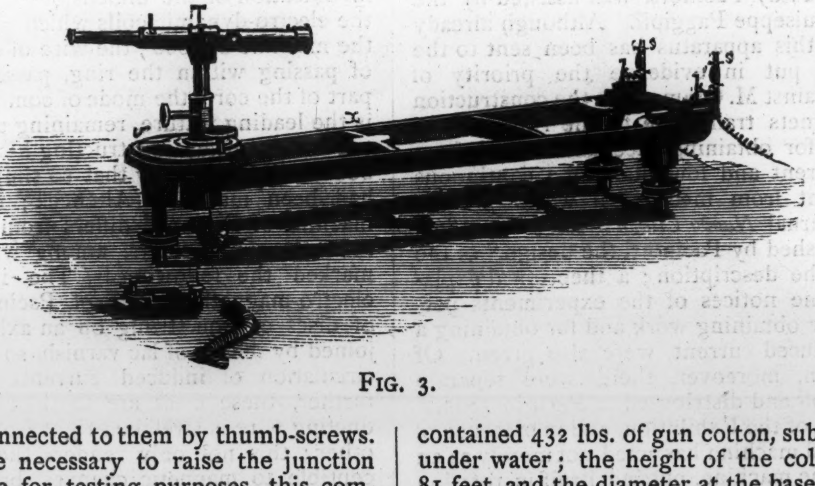

FIG. 3.

It is of importance that the firing of torpedoes be controlled from the shore when practicable, so that they may be rendered safe for the passage of friendly vessels by disconnecting the *firing battery*. In certain cases, however, as for instance, when blockading a harbour or protecting channels, what are known as *electro-mechanical torpedoes* are made use of. This system differs from the *electro contact system* only in employing a *submarine battery*, fig. 12. The torpedo with its *circuit-closer* is first moored with a sinker, and the electric cable towed to a safe distance, when the submarine battery is attached and gently lowered into a position where it may be recovered at will.

Fig. 13 is a sketch of a torpedo explosion, drawn to scale from a photograph taken when the column of water was at its highest elevation. The torpedo contained 432 lbs. of gun cotton, submerged 27 feet under water; the height of the column measured 81 feet, and the diameter at the base 132 feet.

On either flank of our imaginary harbour, fig. 1, (page 449) are laid down some purely mechanical torpedoes, M, M, to complete the line of defence, but as these are not of an electrical nature, they are beyond the scope of the present article. Indeed, submarine warfare has developed of late years into a distinct science, and has been so perfected in all its details, that we have only attempted to give a general outline of the most approved electric systems at present in use.

Fig. 3, which we give here, shows the "*converging arc*," which was alluded to in the first portion of the article, but which was then accidentally omitted.

[For many of the details in the above article, we are indebted to Mr. J. Rymer-Jones, of the India-Rubber, Gutta-Percha and Telegraph Works Company, who has also kindly furnished us with the drawings.—ED. TEL. JOUR.]

FOREIGN SECTIONS.

(*Italy.*)

PACINOTTI.

THE pieces of apparatus sent by Antonio Pacinotti to the International Exhibition of Electricity in Paris in 1881, are the following :—

1. A small electro-magnetic and magneto-electric machine, with an electro-magnet transverse to the ring, constructed in 1860.
2. A magneto-electric machine, with an electro-magnet transvers to the coil, to be moved by hand.
3. A magneto-electric machine, with a transverse electro-magnetic fly-wheel, to be moved by a driving-belt.
4. Pair of discs for the study of the electricity developed by molecular attraction.

We will give as briefly as possible a description of these pieces of apparatus :—

1. The little electro-magnetic and magneto-electric machine, which is shown by fig. 1, has an electro-magnet transverse to the ring; it was constructed by Pacinotti in 1860, and in its construction (which was done at the expense of the Cabinet of Technological Physics of the University of Pisa) Pacinotti was assisted by the mechanician Guiseppe Paggioli. Although already somewhat old, this apparatus has been sent to the Exhibition to put in evidence the priority of Pacinotti, as against M. Gramme, in the construction of electro-magnets transverse to the ring, and in their use, both for obtaining mechanical work from the electric current and for obtaining a continuous induced current from mechanical work. In the part of the journal *Nuovo Cimento* for June, 1864, there was published by Pacinotti the design[*] of the machine with the description; a theoretical explanation and some notices of the experiments performed both for obtaining work and for obtaining a continuous induced current, were also given. Of this publication, moreover, there were separate copies struck off and distributed in Paris in 1865.

In the palace of the Exhibition, and in presence of the jury, the old machine has acted not merely as an electro-magnetic machine, putting itself in rotation when a current was sent through it, but it has also acted as a magneto-electric machine when made to turn by hand; it has effected the deviation of a galvanometer needle by the continuous induced current which it produced.

The principal value of the little machine constructed by Pacinotti in 1860 consists in the following arrangement, which constitutes the principle of the transverse electro-magnet. One end of the wire of each of the numerous electro-dynamical bobbins, which in this machine cover the light wire ring, is connected with the beginning of the wire of the next bobbin by means of the corresponding contact-piece of the commutator. The polar armatures extended in the fixed inducing-magnet, the teeth in the light iron ring, the brass cross-piece of the support, and the double range of contacts in the commutator, are other peculiarities in the apparatus. It may be mentioned that the friction-wheels on the commutator were used by Pacinotti to diminish the friction when the machine was worked with a small motor; but that in the first experiment, when the machine was adapted to give the induced current, it was moved by hand in preference to adapting friction-wheels upon the commutator to diminish the resistance to the passage of the electric current. The compensation disc bearing these friction-wheels figures among the objects exhibited.

In the description of the Gramme machine, given by M. Gaugain (the construction of the first apparatus), in *Annales de Chemie et Physique*, March, 1873, friction discs are shown, which greatly recall the wheels in the Pacinotti machine.

2. Pacinotti, in September or October, 1873, constructed the magneto-elecric machine, shown by fig. 2, which has an electro-magnet transverse to the coil; this machine had a light electro-magnetic coil, which was applied in some experiments by means of a temporary support. In 1874, the machine was arranged with a fixed electro-magnet, and there was published in the *Nuovo Cimento*, in the part for September and October, 1874, a notice of the construction and of the experiments performed.

The electro-magnetic bobbin is not a simple modification of the dimensions of the core and of the electro-dynamic coils which covered the ring of the machine of 1860; the wire of each coil, in place of passing within the ring, passes to the opposite part of the core, the mode of communication, which is the leading feature, remaining unchanged.

Pacinotti when constructing his electro-magnetic bobbin, did not know that so simple a modification had been made by Alteneck; nevertheless, the machine of Pacinotti differs from that of Alteneck in various particulars, among which may be remarked the following: The iron core of the electro-magnetic bobbin of Pacinotti is composed of discs of iron strung on an axle of rotation and joined by means of lac varnish, so as to prevent the circulation of induced currents upon the core; further, these discs are toothed so that the conducting wire is stretched right from one coil to the other; this not only renders the iron more susceptible to magnetic changes, but it also renders the construction more durable, since the turns of the conducting wire are thus protected from friction against one another. Another common peculiarity, which is indicated in the notice published in the year 1874, is the possibility of getting a greater amount of current by having upon the commutator

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[*] For copies of these designs see TELEGRAPHIC JOURNAL for July 1, 1879.

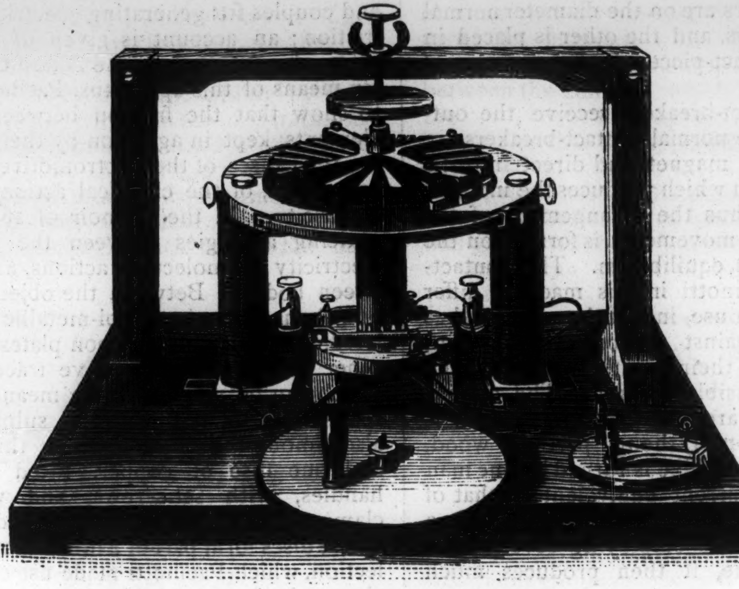


FIG. 1.

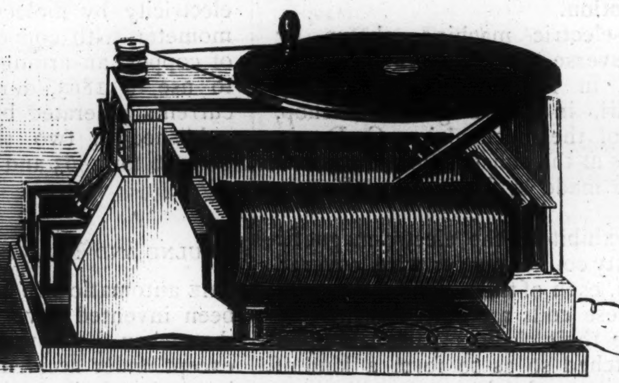


FIG. 2.

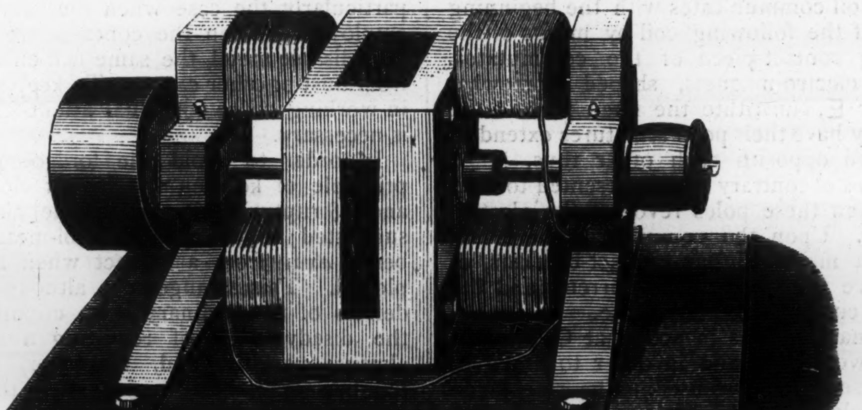


FIG. 3.

four contact-breakers, in place of two only; one pair of such contact-breakers are on the diameter normal to the influencing poles, and the other is placed in the width of two contact-pieces in the direction of rotation.

The movable contact-breakers receive the outside current, whilst the normal contact-breakers are connected to the fixed magnet, and direct into it a current in the direction which produces the increase of the magnetism. Thus the arrangement of the machine, as regards its movements, is formed on the conditions of a stable equilibrium. The contact-breakers used by Pacinotti in this machine differ from those generally in use, in that the wire brushes instead of pressing against the commutator with their sides do so with their points, so that as they wear they are not sensibly injured. The dimensions of the machine are not great, its weight is only 30 kilos.; the support, though partly of wood, is strong. When the machine is turned by one man it gives an external current equivalent to that of two or three Bunsen elements; but by adding a driving band to a ring and employing several men to move the machine, it then produces much stronger currents.

In the Exhibition the current given by this machine has generally been used to put the foregoing machine in motion.

3. The magneto-electric machine, shown by fig. 3, has a transverse electro-magnetic ring; it was constructed in the spring of 1878 by Pacinotti at Cagliari, in the Doghio workshop, with the assistance of the mechanician, G. Dessi; but the first attempts at the construction of electro-magnetic rings were made by Pacinotti at Pisa in the spring of 1875.

In the machine exhibited, the electro-magnetic ring consists of twenty coils of copper wire, covered with silk and varnish, each of them having the form of the letter D. These coils are united to the axle of rotation and have their circular parts laid upon each other and stretched so as to form a kind of ring. Such electro-magnetic rings, moreover, can be called transversal, since, according to the principle of transverse communication, the end of the wire of each coil communicates with the beginning of the wire of the following coil by means of the corresponding contact-piece of the commutator. Two large electro-magnets, shaped somewhat like the letter E, constitute the fixed part of the machine; they have their polar armatures extended, and are placed opposite each other thus, E ∃, with their poles of contrary name presented to each other. Between these poles revolves the electro-magnetic ring. Upon the commutator there are, as in the first machine, four contact-breakers, of which two give the magnetising current, and the other two the current for external use.

This ring machine was in action at Cagliari, in the Doghio workshop, and in order to move it, about one horse-power was used. The ring made about 600 revolutions per minute at first, and then the external current maintained at bright redness an iron wire, six-tenths of a millimetre in diameter and 25 centimetres long, and caused it to fuse when the length was reduced to about one decimetre; between carbon points the machine maintained a very good electric light. The total weight of the apparatus was a little more than a hundred kilos.

4. Besides the machines, Pacinotti exhibits discs and couples for generating electricity by molecular friction; an account is given of their use in two memoirs contained in the *Nuovo Cimento* for 1875. By means of this apparatus, Pacinotti has proposed to show that the friction between the molecular elements, kept in agitation by thermic movements, are the causes, of the electromotive force occasioned by contact, of the chemical action, and of thermo-electricity. In the memoir of 1875 he begins by noticing analogies between the developments of electricity by molecular actions, and of friction between bodies. Between the objects exhibited is a numerous collection of bi-metallic pairs, well insulated, which, if rubbed upon plates of ebonite, or of other non-conductors, leave traces of electricity, which can be recognised by means of the electroscopic dust of red lead and sulphur. There are also, among the objects shown, three discs of zinc and one disc of copper, fitted with insulating handles, with set-screws, and with connecting clamps, two of which are covered with paraffine. These discs form part of a much more numerous collection, which Pacinotti made use of in studying the electrophoric action in the disc experiments of Volta.

Finally, among the objects exhibited (in connection with the numerous couples for producing electricity by molecular attrition) is a small actimometer, with copper plates immersed in sulphate of copper, an arrangement which Pacinotti began to use in 1863, during the study of the electric currents generated by the action of heat and light, published in two short memoirs in the *Nuovo Cimento* for 1863 and 1864.

(*France.*)

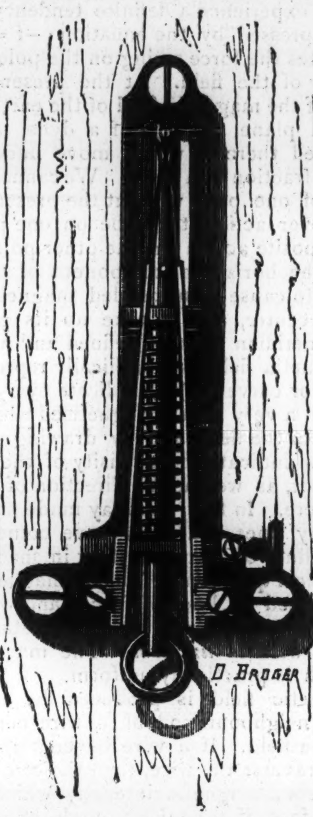
Gaulne and Mildé's Electric Fire Signaller.

The automatic fire signallers which have hitherto been invented have possessed the possible defect that when the apparatus is not required to work, except under accidental circumstances, and at long intervals of time, their contact surfaces become oxidised, so that the current does not pass at the time when it is required to do so; this is more particularly the case when mercury contacts are employed. When the contacts are made with an inoxidisable metal, the same bad effect takes place, from dust or other causes. To keep such apparatus in working order continual attention and cleaning is necessary.

In order to avoid the foregoing defects, the principle of keeping the circuit closed normally, and of rupturing it to give the alarm, has been suggested; for this purpose a bi-metal plate, which bends *away* from a contact when heated is employed. This arrangement, although it avoids the defects of the ordinary open circuit method, has the disadvantage of requiring a battery to be always working, and, moreover, it requires a number of indicators, in order that the exact locality of the fire may be able to be announced.

The apparatus of M. Gaulne, which is shown by the figure, is designed with the object of avoiding all the defects of the inventions previously devised; it is, moreover, very inexpensive. The signallers take the place of the ordinary electric push button in the usual electric bell systems, in fact, are used for ordinary ringing purposes. In this case, the current passes by the action of the person who requires to ring; when, however, a fire takes place, the apparatus works automatically.

The invention consists of a plate of metal, secured to the wall of the room near the ceiling by three screws. The leading wires of the apparatus are connected to metal terminals, fixed at the lower part of the whole. To each of the bosses of these terminals are secured straight compound metallic springs, formed of brass and steel; these springs, which form an acute angle with each other, have their brass portions (which are on the outside of the angle) terminated a little distance short of the apex of the angle, but the steel portions are carried further up, and have their inner ends faced with platinum. These ends, although in close proximity to each other, do not normally touch. In the vertical axis of the plate, and behind the springs, is a rod, which slides vertically in guides; the lower end of this rod is terminated by a ring (to which can be attached the bell cord) and the upper end has a projecting pin, which rubs between the two platinum surfaces of the springs when the rod is pulled down. This rod is normally held up, and brought back into the position shown, by means of the spiral spring.



The action of the apparatus is obvious; when the rod is drawn down by means of the bell cord, the pin rubbing between the platinum contacts completes the circuit. If, on the other hand, a fire breaks out, the springs become heated and bend inwards until the contacts touch, and thus complete the circuit; in this case the lengthened ringing of the bell indicates that the cause is not due to the simple momentary pull of the bell cord. It is obvious that no amount of rough pulling of the cord can interfere with the sensibility of the springs, whilst the continual friction of the pins between the contacts, which results from the use of the cord, keeps the contacts clean.

In order that the apparatus may be set to ring at any required temperature, a set screw is provided, which regulates the distance between the contacts; this screw has an index hand, which moves round a dial graduated to thermometric degrees, so that the apparatus can be set to act at any required temperature.

ON THE PRACTICAL MEASUREMENTS OF ELECTRICAL MAGNITUDES.

By W. H. PREECE, F.R.S., Electrician to the General Post Office, London.

(*Continued from page* 467.)

WE propose to consider only one derived system, viz., the electro-magnetic system of c. g. s. absolute units, and to leave the question of the conversion of this system into another system for future consideration. I give in a foot-note those equations which are most frequently in request.*

10. This British Association electro-magnetic system of electrical units is well represented in the following table:—

Symbol.	Electrical quantities.	Nomenclature.	C. G. S. units
R.	Resistance	Ohm	10^9
E.	Electromotive force	Volt	10^8
K.	Capacity	Farad	10^{-9}
Q.	Quantity	(Ampère)	10^{-1}
C.	Current	Weber	10^{-1}

It will be seen in the c. g. s. system that the absolute units of resistance and electromotive force are so small, that very large numbers have to be used to bring them within practical limits. The units of quantity, current, and capacity are so large that fractions only can be used. Christening these units with names has had a happy practical effect. The only unit that has not yet had a name is that of quantity, and *Ampère* has been suggested† as one worthy to rank with the other illustrious names that have been applied so usefully. Symbols have been attached to each magnitude, and it would be a great convenience, especially to students, if physicists would invariably use the same symbols to represent the same quantity. The letter thus becomes a kind of short-hand symbol conveying at once the same idea as the

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* *Fundamental Units.*

Length = L. Time = T. Mass = M.

Derived Mechanical Units.

$$\text{Velocity} = \text{V} = \frac{\text{L}}{\text{T}}. \quad \text{Force} = \text{F} = \frac{\text{LM}}{\text{T}^2}. \quad \text{Work} = \text{W} = \frac{\text{L}^2\text{M}}{\text{T}^2}.$$

Electro-Magnetic Units.

Magnitude.	*Symbol.*	*Dimensions of Unit.*
Quantity of Electricity	Q	$L^{\frac{1}{2}} M^{\frac{1}{2}}$
Electromotive Force...	E	$L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2}$
Capacity	K	$L^{-1} T^2$
Current	C	$L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1}$
Resistance..................	R	LT^{-1}

† Johnstone Stoney, British Association, 1874.

word. I insert those usually adopted in England, but the practice there is very varied, and authors seem to delight to confuse their readers by making free use of all the alphabet to indicate at different times the same quantity.

In the practical application of these units, multiples and fractions have to be largely used. Thus, while the ohm is a very convenient unit for ordinary "conductivity" measurements, it leads to the use of very high numbers when "insulation" has to be expressed. A multiple of the ohm is therefore used as an insulation unit; 10^6 ohms has been adopted for this purpose, and is called the *megohm*. On the other hand, the farad or the unit of capacity is too large, and $\frac{1}{10^6}$ of it, or the *microfarad*, is that used. The *weber* is much used for electric light and for the transmission of power purposes, but it is too large for telegraphic purposes, so that a fraction, the *milliweber* or 10^{-3} weber, is used as an useful unit, and for certain physical researches the microweber or 10^{-6} weber is sometimes used.

Index symbols similar to those used to indicate degrees of temperature, have also been suggested and are much used. The ohm is indicated by the Greek Omega ω, and the megohm by Ω; the weber is indicated by the Greek gamma, Γ, and the milliweber by the small gamma, γ. The other quantities might also be conveniently indicated in the same way. Thus, as 12° indicates 12 degrees, so 12^{ω} would indicate 12 ohms, 12^{Ω} 12 megohms, 12^{Γ} 12 webers.

11. Now such being the practical system of electromagnetic units, the question remains for discussion:—How can electrical magnitudes, which apparently seem so entirely independent of time, mass, and space, be measured by reference to their fundamental units? *Resistance* is the obstruction which matter opposes to the passage of electricity through it. Hence to measure resistance we must be able to measure the flow of electricity, or the quantity of electricity that passes in a given time through a conductor. The transference of electricity from one point of a conductor to another is invariably accompanied by work done or energy expended; for instance, magnets are moved, heat is generated, light is produced, or chemical decomposition is effected; so that to measure the quantity of electricity passing, in other words to measure *a current of electricity*, we must measure either the force it exerts upon a magnet in its immediate neighbourhood, or the amount of heat it produces, or of work it does in a given time.

We will consider the first method only, or the electromagnetic effect of Œrsted. Here we have a current of electricity acting upon a magnet so as to cause it to move, and before we can measure the force exerted by the current upon the magnet, we must be able to express the strength of the magnet itself in the same system of units.

12. It is the fundamental law of magnetism—the law of Coulomb—that unlike poles attract while similar poles repel each other with a force (F) which varies directly as the product of the intensity of magnetism of each pole (m, m^1), and inversely as the square of the distance (d) separating them. This law is expressed by the formula:—

$$F = \pm \frac{m,\ m'}{d^2} \qquad (1)$$

— indicating attraction and + repulsion.

In other words, one pole exerts force on another pole, and if one pole repels a similar pole at a centimetre distance with the force of a dyne, that is, with such a force that the pole, if free, will move with a velocity of one centimetre per second, we have the unit magnetic pole, for if F be 1 and d be 1, m and m^1 must each be 1. The unit magnetic pole has not yet received a name. If one were wanted a better name than *Gauss* could scarcely be selected, unless it were that of *Coulomb*. But we may disregard the second pole, and confine ourselves to the space affected by the magnetism of the one pole. The neighbourhood of a magnet is called a *magnetic field*, and as the earth is regarded as an enormous magnet, any portion of space about its surface is a portion of its magnetic field, and the intensity of this field can be measured by the force with which a pole of a magnet is affected when placed there. In fact, the intensity of a magnetic field, is the force which unit pole experiences when placed there. If free to move, it would move with a defined velocity; if fixed, it would experience a definite tendency to move. This fact is expressed by the equation:—$f = m\ h$, (2) where f indicates the force acting on the pole m, and h is the intensity of the field. At the present moment the intensity of the magnetic field of the earth at Paris, in a horizontal plane, is ·1776 of a dyne, and if unit pole were placed there, it would move under the influence of that fraction of a dyne. We cannot conceive the existence of one pole without the presence of the other. Whatever action there be on one pole, there must be an opposite action on the other pole. Hence the effect of the horizontal component of the earth's magnetism, is to cause a suspended magnet to move about its fixed centre, and to take up its position in the magnetic meridian with a defined and measurable force. A magnetic field is graphically represented by drawing lines, or curves, which indicate everywhere the direction which a very small magnetised needle would take if moved in the field, and by drawing these lines to scale, we can indicate the intensity of the magnetic field at any spot, as well as the direction of the force experienced there. In fact, Faraday made such use of these imaginary lines, that they have come to be regarded as real lines of force, existing in space and determining physical questions. Thus a magnetic field is said to be traversed by lines of force, and when these lines of force are parallel, and at equal distances from each other, the field is *uniform*. The magnetic field due to the earth is practically uniform.

But a magnetic field is produced by an electric current. The neighbourhood of a wire conveying a current is such a field. If a wire be bent in a circle, and a current traverse the wire, then the centre of that circle will possess a magnetic intensity which is easily measured. In fact, if we take a circle of one centimetre radius, and cause a current to flow along an arc of one centimetre length of this circle, this current can be adjusted so as to exert unit force on unit pole at the centre, and that current will be unit current, and it will produce a magnetic field of unit intensity at the centre. If the current circulates through the whole circumference of the circle it will exert 6·2832 units of force at the centre. This unit current is the c. g. s. unit current.

Hence currents can be measured by the forces they exert, and these forces being measured by the fundamental units, currents of electricity can be measured by the same system.

13. Now comes the question—How are currents of electricity produced? Currents are dependent upon but two quantities. *Electromotive force** and *Resistance* whose relations were determined by Ohm, and expressed by his well-known formula. Faraday showed that if a wire be moved through a magnetic field, in such a way as to cut the lines of magnetic force at right

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* Electromotive force is the difference of electric pressure (potential) that determines the flow of electricity. It is an expression analogous to the difference of temperature that determines the flow of heat, and to the difference of level that determines the flow of water, and to the difference of pressure that determines the flow of air or gas.

angles, an electromotive force will be determined in that conductor, and a current will flow if the wire forms a closed circuit. The strength of this current will depend upon the intensity of the magnetic field (H), the length of the conductor (L), *the velocity with which the conductor moves across the line of force* (V), and the resistance of the circuit (R). These relations are given by the equation:—

$$C = \frac{VHL}{R} \qquad (3)$$

Hence if we have a uniform magnetic field of unit intensity ($H = 1$), and if the resistance of the circuit be unity ($R = 1$); then if the conductor of unit length ($L = 1$) move through the lines of force at right angles to their direction and to its own length with unit velocity ($V = 1$), we should have ($C = 1$) unit current. Hence current can also be measured by the velocity with which a wire moves through a magnetic field, and hence it is dependent upon the fundamental units of time and space.

14. Having thus a measure of the current in terms of the fundamental units, we have also a measure of the electromotive force and resistance of the circuit in the same units. It is evident in Ohm's formula—

$$C = \frac{E}{R}$$

that if C be 1 and E be 1, R must also be 1. If we can generate unit current in unit magnetic field by unit velocity, the electromotive force producing that current must be unity, and the wire conveying that current must have unit resistance. For in equation (3) if C, V, H, and L each be 1, R must be 1 also. The resistance of the circuit and the electromotive force produced in such a field by the velocity of one centimetre per second must be so small that, although they would be the c. g. s. absolute units of electromotive force and resistance, it has been necessary in order to form a practicable system to take a much higher velocity. In fact, a velocity of 10^9 c. g. s. absolute units has been taken for this purpose, or the practical unit of resistance has been made of such dimensions that it requires a velocity of one thousand million centimetres per second to produce unit current through it under similar circumstances.*

This is the unit resistance that has been called *an ohm*, and which is said to be equal to 10^9 centimetre-seconds, and often, and very improperly, said to be equal to a velocity of 1,000 million centimetres per second. Resistance is a property of inert matter, and velocity is motion, and it is confusing, as well as a misuse of language, to say that resistance is velocity. It is perfectly true to say that the formula or dimensional equation, which represents resistance in the electromagnetic system of units, is the same as that which represents velocity, but this is only true for that system of units, and it is not true for all other systems. For instance, in the electrostatic system, a system based on Coulomb's electrostatic law, instead of the electromagnetic law, resistance and velocity have not the same dimensional equation.

Some writers have carried this concert so far as to express velocities by ohms. Thus the velocity of light has been given as 2·98 ohms.

15. The *Ohm* has been approximately measured by the Committee of the British Association (1861—69), who expended a very great deal of care upon the operation, but in spite of all this care exercised by the most accomplished experimenters of the day, the standard obtained was pronounced, and is known to be, only approximately near the truth. It has been examined by the following physicists with the results given in the table.

1864.	B. A. Unit	1·0000.
1870.	F. Kohlrausch	1·0196.
1873.	Lorenz	·9797.
1876.	Rowland	·9912.
1877.	H. F. Weber	1·002.
1881.	Rayleigh and Schuster ...	·9895.
	Mean	·9932.

Unfortunately the name *Ohm* has been given to the approximate coil and not to the real unit, viz., 10^9 c.g.s. absolute units of resistance. This inaccuracy and this misapplication of the name has left the ground open to the claim of rival units, but only one maintains the field, and that is the Siemens unit, which is the resistance of a column of pure mercury at 0° C., one metre long and of one square millimetre sectional area. There is no reason whatever, of a scientific nature, to justify the retention of this unit except its close approach in magnitude to the true ohm. Had it been a column of mercury 1·0475 meter long it would have been a closer approximation to the true ohm than probably the B.A. unit coil itself. Indeed it is questionable whether a better approach to the ohm could be produced than to adopt Dr. Siemens' method with the corrections necessary to make it the nearest possible approach to this scientific unit. The fundamental units themselves are inexact, and we must be satisfied with mere approximations. As knowledge and skill increase so must greater and greater exactitude be experienced in any new determination of the material standard. A committee of the British Association is now working at the question, and a fresh measurement of the ohm is going to be made on a new method, devised by Professor Carey Foster.

The Committee of the British Association deposited several coils, constructed in different ways and of different metals, in the observatory at Kew.* These were examined in 1867 by Mr. Hockin, and were found to have suffered no change. They were again examined in 1876 by Professor Chrystal, when seven were found constant, but one, that made of Platinum-silver alloy, was found to have deteriorated. They are again about to be examined by the Committee of the British Association. Efforts are also going to be made to obtain for it a legal status in England.

What is wanted is some central establishment for the periodical examination of standard coils and measures, and for the granting of certificates of the correct value of those sent for verification.

(*To be continued.*)

ERRATUM.—November 15th, page 467, last sentence of par. 8—for "$7·46 \times 10^9$ ergs" read "$7·46 \times 10^6$ ergs."

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* It is practically impossible to produce currents in the simple way indicated above. The Committee of the British Association employed a method suggested by Sir William Thomson. They used a circular coil of insulated wire rotating around a vertical axis, in the centre of which a small magnet was suspended in the magnetic meridian, and which was deflected by the currents generated in the revolving coil through its wire cutting the lines of magnetic force of the earth. Great care, very numerous precautions, many corrections had to be made for the irregularity of the lines of magnetic force of the earth, for imperfect adjustments of the coil and magnet, for induction of the magnet on the coil, for self-induction of the coil, for tension of the suspended fibre, for change of temperature, &c. The result was an approximation only to the true Ohm, but which however has been made the standard of reference in England. Coils of wire were made to represent this resistance which were distributed and sold.

* Two coils were made of platinum and two of mercury, while two were made of each of the following alloys;—

Gold-silver.
Platinum-silver,
Platinum-iridium.

The wires of which the coils were made varied from 1 metre to 2 metres long, and from 0·5 mm. to 0·8 mm. in diameter. They were insulated with silk and saturated with paraffine They are now in the Cavendish Laboratory in Cambridge.

Notes.

ELECTRICAL DIRECTORY.—We have received a specimen page of an *Electrical Directory of England* which will shortly be published by Mr. J. A. Berly, the well-known electrical engineer. The volume will be a complete record of all the industries directly or indirectly connected with electricity and magnetism, and will contain the names and addresses of manufacturers, &c. Every trade which is in any way connected with electricity will be represented. There can be no doubt but that the work will be an extremely useful one, and that no one is more competent than Mr. Berly to make it a success. The general arrangement of the book (as far as can be gathered from the specimen pages) is all that can be desired.

NEW ATLANTIC CABLE.—It is reported that a company is in treaty with Mr. W. T. Henley with reference to the manufacture of a new Atlantic cable.

THE ELECTRIC LIGHT AT BRIGHTON.—The Commissioners for the District of Hove, Brighton, decided at a meeting, held on the 17th ult., to illuminate that portion of the town by the Brush light. It is estimated that the annual cost will be £2,000, as against £1,900 for gas lighting. At the forthcoming Health Congress and Sanitary Exhibition, which will be held in the town in the beginning of December, it has been decided to invite the various patentees to exhibit their electric lighting apparatus, and the gas committee are to recommend the council to expend £300 for the erection of a shed for housing the engines and apparatus.

THE ELECTRIC LIGHT AT THE FIJI ISLANDS.—During the recent visit of the sailor Princes to the Fiji Islands, a display of electric light from the flagship was made. The natives, who for the first time beheld the light, were both astonished and gratified.

THE ELECTRIC LIGHT AND TORPEDOES.—An experiment was made recently with the electric light on board the *Sultan*, at Portsmouth, which will probably effect a revolution in the arrangement and working of the powerful beam which is used in her Majesty's ships for discovering the approach of a torpedo attack at night. As the torpedo detectors are now fitted on board, both the lamps and the men in charge are from their exposed position conspicuously open to attack; the light itself would indicate the vulnerable part; and torpedo craft would no doubt begin the assault by destroying the electrical apparatus by means of their machine guns. As a means of removing this very obvious danger, the dockyard authorities at Portsmouth hit upon the idea of testing the applicability of reflected light for searching purposes at sea. With this object in view an iron tube, 3 ft. 7 in. in diameter, or just capable of containing the ordinary-sized lenses, was carried through the forward hatchway, and extending from the lower deck to about a couple of feet above the top of the funnel when housed for safety. The portion of the tube between the main and the lower deck is made portable, so as to enable the lenses and lamp to be adjusted. The lamp, which is one of Professor de Monnier's, is fixed on a vertical slide within the tube between decks, and is consequently so protected as to be impervious to attack. The carbon points are placed obliquely, and are so arranged that they can be revolved to suit different practical conditions. At the bottom of the tube and below the light, is a plano-concave reflector, while immediately above the light is a dioptric lens; the upper and exposed end of the tube is surmounted by a square iron hood, about four feet in height. This is made to turn in any direction round the tube upon a roller path, and inside of which is a mirror, 3 ft. in breadth and 4 ft. in height, and mounted on a pivot, so that by means of gearing it can be made to project the reflected beam from below at any angle of elevation or depression that may be required. The current is generated by the ordinary apparatus with which ships of war are now provided, and which in this case consists of a D Gramme machine driven by a Brotherhood engine. The system seemed perfectly practicable and under control, but further experiments will be made with the object of testing the merits of different lenses.—*Daily Telegraph.*

REMARKABLE PROPHECY CONCERNING THE ELECTRIC LIGHT.—In a copy of the *Times* for 1878, we have come across an amusing piece of correspondence with reference to the future of the Jablochkoff electric light; the writer of the letter is at the present time not unknown in connection with a system of electric lighting by incandescence; we presume he has seen reason to modify his opinions within the last year or two. The following are extracts from the letter in question:—

"The Jablochkoff candle, as is well known, is worked by alternating currents, or, as it might be said, its action depends on the alternate filling and exhaustion of the electric fluid from the conductors used for conveying the electricity; it is, therefore, evident that even for moderate distances the Jablochkoff system is quite impracticable. Indeed, so convinced am I of the truth of what I say that I venture to assert and without fear of contradiction that one of these candles, giving a light equal to 100 gas jets, when worked in the ordinary way at a few yards distance, would refuse to give any light at all if removed a mile off, however low might be the resistance of the conductors leading to it; the retardation due to the inductive capacity of the conducting cable and the development within it of 'extra currents' so reduces the available electromotive force at the ends of the carbons as to be insufficient for the working of the candle. . . . . Again, another difficulty to be contended against in the use of these intermittent currents through long lines is that of insulation; for, as telegraphists well know, insulation in these circumstances becomes a very difficult matter, and the laws governing it are of a very complex nature. In short, when using alternating currents, the light will be found to decrease with the distance according to some function which very soon becomes for all practicable purposes infinite. I see that the Jablochkoff light is to be used for illuminating the Thames embankment. Here it will be necessary to have about half-a-dozen complete electric works all along the series of lights, one at least for every three candles; but there is no doubt that it will be exceedingly pretty, and I think the Board of Works might as well try the effect of red fire while they are about it—say once a week as a change."

THE ELECTRIC LIGHT IN BRISTOL.—At a recent meeting of the Bristol councilmen a committee was appointed on the motion of Mr. William Smith to report on the practicability or otherwise of utilising the action of the tides and of non-tidal waters, for the purpose of obtaining power by the storage of electricity, to be applied to industrial purposes, for the lighting of the city, or to other uses. Mr. Smith read a letter from Sir Charles Bright, to show that the proposal is a practicable one, and stated that the available tidal power at the mouth of the river is 50 billion foot pounds per annum, or 859,659 horse-power per tide. Five miles higher up the river, at Totterdown, the available energy is 6½ billion foot pounds per annum, or 279,389 horse-power per tide. Mr. Smith did not suppose they could utilise even one-hundredth of this power, but what they could utilise would be sufficient to light the city by electricity. They now used about 80 billion cubic feet of gas per annum, the total amount of energy in each cubic foot being 500,000 foot pounds. The city therefore expended 40 billion foot pounds of energy in burning gas, of which, probably, 35 billions or more were wasted in merely warming the air or producing smoke inside the gas lamps. Sir Charles Bright had volunteered to visit the city for the purpose of examining the river. A committee was ultimately appointed to consider the question.

The Electric Light on the Midland Railway.—The Midland Railway Company is about to make an important experiment with the electric light, viz., the lighting of the whole of the Erewash Valley, stations, sidings, and signals. Power is to be obtained from one engine at Chesterfield to light as far as Alfreton, and by another engine at Nottingham to light as far as Pye Bridge. The Erewash Valley has been selected for the experiment on account of there being so many stations, junctions, sidings, and branches, within so short a distance.

The Edison Electric Light.—A correspondent of the *Times* says Mr. Edison is at present supplying 1,100 houses in New York city by meter, at the same rate as that previously charged for gas, and is making a very large profit.

The Electric Light at the Paris Opera.—The experiments at the Paris Opera with the electric light have been successful so far as concerns the incandescent light, which is now regularly used. A final decision on the matter will be come to very shortly.

The Electric Light Companies.—The British Electric Light Company have given notice that during the next Parliamentary session they will apply for an act to authorise and empower the company to break up roads, &c., to enable wires to be laid down to supply electric power for lighting and other purposes. The Electric Light and Power Generator Company apply for similar powers. The Oxford Gas Company, in addition to asking for powers to enable them to make such further extensions to their plant, &c., as are necessary for general purposes, will also ask for powers to enable them to light by the electric light and to apply the use of gas for heating purposes, either directly or through the medium of the electric current.

Action of Cold upon the Voltaic Arc.—By M. D. Tommasi.—When the voltaic arc passes between two rheophores of metal, for instance, of copper, each formed of a tube bent in the shape of a U, traversed by a rapid stream of cold water, and placed horizontally opposite to each other, the following facts are observed:—

1. The illuminating power of the arc is much diminished; it is reduced, so to speak, to a simple luminous point, even on employing a very intense electric current (50 to 75 Bunsen elements, large size).

2. The arc, if it may be so called, is very unstable, so that it is extinguished by the slightest breath of air, or by attempting to light a match at it.

3. If there is placed above the arc, at the distance of 0·004 to 0·005 metre, a piece of paper, a black spot appears after a few moments, which extends, and ultimately penetrates the paper, which, however, is not kindled.

4. The arc consists of a luminous globule, oscillating upwards and downwards between the two rheophores. The form of this globule and its great mobility, recall a drop of liquid in the so-called spheroidal state.

5. On presenting to the voltaic arc the south pole of a magnetic rod, the arc is attracted, and approaches the magnet to such an extent that it is drawn away from the rheophores, and is extinguished. The same fact is observed, though in an inverse direction, on presenting the north pole of the magnet.

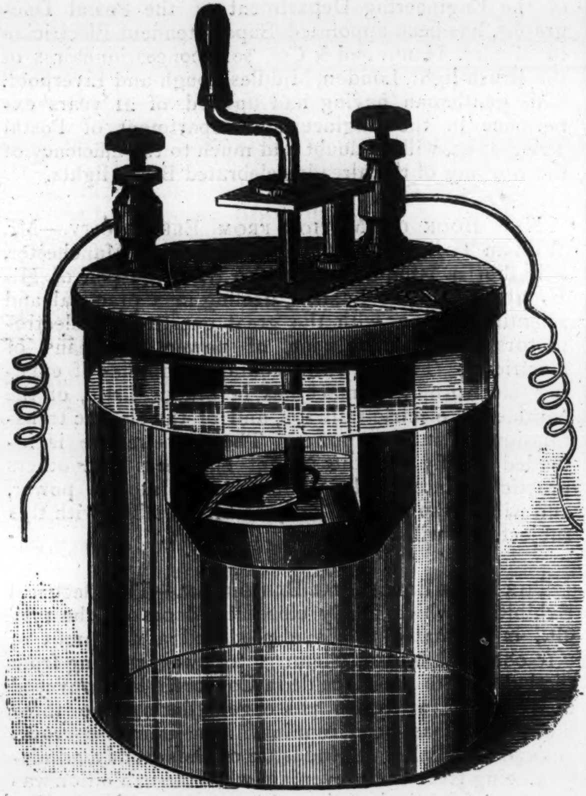
6. The quantity of ozone given off seems to be greater than when the arc is not refrigerated. It is to be remarked that notwithstanding the refrigeration of the rheophores, the flame of the arc is greenish, proving that some of the copper is burning. It is further to be asked if the arc would be produced on using for rheophores two platinum tubes, in which alcohol cooled down to — 30° C. (— 22° F.) is made to circulate.—*Comptes Rendus.*

The Brush Electric Light.—Mr. Samuel Vyle, of the Engineering Department of the Postal Telegraphs, has been appointed Superintendent Electrician to Messrs. Hammond & Co., sole concessionnaires of the Brush light, London, Middlesbrough and Liverpool. This gentleman, having had upwards of 21 years' experience in the Engineering Department of Postal Telegraphs, will no doubt add much to the efficiency of the working of the already celebrated Brush lights.

New Book on Motion from Electricity.—Mr. William T. Emmott, of Blackfriars-street, Manchester, will shortly issue a new treatise from the pen of Mr. Urquhart, C.E., of London, dealing in a practical and scientific manner with the great questions of electro-motors, and transmission of power by means of electricity. The work will contain examples of existing electro-motive machines in practical use, of the continental electric railways, and of the electric transmission of motive power. The new treatise is intended chiefly for the use of engineers and others practically interested in this form of motive power, and will be the first work of the kind dealing with this subject. It will be profusely illustrated.

The Paris Electrical Exhibition.—The Electrical Exhibition, which finally closed its doors on the 17th ult., is estimated to have produced a net profit of £16,000, and Messrs. Siemens' tramway, running from the building to the Place de la Concorde, has conveyed no fewer than 84,000 passengers during the three months it has been running. An immense crowd besieged the Palais de l'Industrie on the last day, admission being free. In the evening, when the exhibition was illuminated for the last time, there was scarcely standing room either in the main hall or the galleries, most of the visitors being of the artisan class out for their weekly holiday. The usual custom of closing exhibitions by a general letting loose of all the noisy elements contained in the show was observed on this occasion with an almost deafening effect. Shortly before eleven the whistles of all the steam-engines and every electric bell in the building were set going, making such an inharmonious din as was certainly never heard before. Fortunately for the hearing powers of the audience, it only lasted a few minutes, and had the desired effect of clearing the palace of its thousands of visitors. The general utility of the Electrical Exhibition has been recognised by the Paris Chamber of Commerce, which recently passed a vote of thanks to M. Cochéry, Minister of Posts and Telegraphs, and M. Georges Berger, Commissioner-General of the Exhibition. The President of the Republic experienced so much pleasure in hearing the voices of the performers at the Opera and the Français through the telephone that he has caused similar communication to that which existed between the two theatres and the exhibition to be established with the Palace of the Elysée. The Opera House, the Théâtre Français, and the Odéon Theatre have thus been connected with the Presidential apartments, where a series of "telephonic" soirées commenced on the evening of the 21st ult. To celebrate the success of the Exhibition, the French workmen invited their foreign brethren to a dinner at the Palais Royal, on the 22nd inst. M. Berger presided, and the entertainment was under the patronage of M. Cochéry.

AN IMPROVED BATTERY.—The engraving shows an improved galvanic battery lately patented by Mr. A. Floyd Delafield, of New York city. This battery is provided with means for increasing the strength of the current by producing a more or less rapid circulation of the solution in contact with the elements by mechanical means, operated by hand or by a motor. This is accomplished practically by fitting the negative element upon a shaft for revolution between the zinc plates, and for increasing the effect the revolving disc is made in spiral form, something like a screw propeller, so that it creates a circulation of solution in the cell, thus continuously depolarising the elements.—*Scientific American.*



ELECTRIC RAILWAYS.—A tram-car on a new electrical system will be soon experimentally run from one end to the other of the Rue de Rennes, Paris. The electric current will be conducted along the inner face of the rails. There will therefore be no wire supported on poles. The scientific world is greatly interested in this experiment. There are electricians who predict the failure of the tram-car in wet weather. The success of the Siemens Electrical Railway has been so great that the Municipal Commission appointed to report on the possible application of electricity will advise the experiment of an elevated railway in some part of Paris. The only objection to the erection of such a line on the Boulevards is its aspect, which it is supposed will not be sufficiently ornamental. A large number of practical suggestions will be made by this Commission.

ELECTRIC BOAT.—A boat destined to be propelled solely by electricity has just been completed, according to *La Lumière Electrique.* The owner, M. Tellier, intends to launch it at Boulogne and to cross in it to Folkestone, in company with a friend. The boat is decked, and is about 18 ft. long by about $4\frac{1}{2}$ ft. wide.

ON THE ABSOLUTE MEASUREMENT OF CURRENTS BY ELECTROLYSIS.—By M. Mascart.—The author has redetermined the electro-chemical equivalent of water. He introduces into a vacuum a galvanometer which contains a solution of phosphoric acid between thin platinum wires as electrodes. The gas given off is collected by a mercurial pump, and its volume is measured when dry. No ozone is formed and no gas is condensed in the electrodes or dissolved in the liquid. It is preferable to prepare a precipitate of silver from the nitrate, using at the same time silver as the positive electrode, which dissolves. The difference between the precipitated and the dissolved silver amounts to $\frac{1}{1000}$. The measurement of the current electro-magnetically, was made by means of an electro-dynamical balance, to one of the scale-pans of which was suspended a long cylindrical spiral in such a manner that its lower surface lay in the plane of symmetry of two large, horizontal flat spirals. The currents enter the movable spiral by two thin, spirally-coiled platinum wires. As the intensity of the current is continually changing, the times are noted in which the attraction of the spirals varies by 10 grms. Finally the equilibrium of the spirals without the current is determined both at the beginning and at the end of the experiments. The quantity of silver, p, proportional to the square root of the attraction, P, in the balance, varied from 700 to 900 mgrms., during an experiment of from 25 to 45 minutes; the attraction in the balance was from 1,500 to 4,000 mgrms. In five experiments the ratio $\sqrt{P}\; p = 132{\cdot}85$ (132·79—132·94). If the coils of the flat spirals are considered as of equal radius and as lying in the same plane, and the section of the movable spirals as very small and their length very great, the attraction is a simple function of the length of the wires, the number of coils, the length of the cylindrical spirals, and the effect upon the balance. If the equivalent of silver is taken at 107·93, the electro-chemical equivalent of water = 0·009373 m.g. Using the absolute units of the British Association, a current of the intensity of 1 weber will decompose 0·09373 m.g. water, or 0·010415 part of the equivalent of a body in milligrams. A current, which in a second decomposes 1 equivalent of a body in milligrams, would be = 96·01 weber.—*Wiedmann's Beiblätter.*

THE DEPOLARISING PROPERTIES OF SALINE SOLUTIONS.—By D. Macaluso.—Lippmann found that a negative electrode consisting of a metal, A, is polarised in solutions of various salts, single or mixed, but not when the solution contains traces of a salt of A.

On the other hand Macaluso found that the polarisation of A in the solution of a salt of a metal, B, is always modified by the addition of a salt of a third metal, C, when C (which, according to Macaluso, occasions the polarisation) is substituted for B in the solution and the more quickly the more energetically this substitution takes place. As the metal, A, does this most powerfully the addition of the salts of A to those of B decreases the polarisation most.

Some objections made by Lippmann (*Journal de Physique*, 10, p. 167) are taken into consideration. Thus Lippmann finds that a cathode of copper in a solution free from copper assumes a permanent polarisation, whilst Macaluso observed that it was quickly depolarised. According to Lippmann this discrepancy is due to the circumstance that Macaluso plunged the copper plate into pure, dilute sulphuric acid and afterwards washed it with distilled water and dried it, whereby a thin layer of a copper salt is supposed to have been formed.

Macaluso shows that this is impossible, as the solution even after prolonged use contained not a trace of copper.

Macaluso finds also that the polarisation of a cathode of copper quickly vanishes in a solution of sulphate of zinc quite free from copper after the passage of feeble currents, but more slowly in case of stronger currents.

When by repeated action of the current, after the polarisation has each time disappeared, it becomes more permanent. This phenomenon is not due to the formation of a copper salt, since on agitating the electrode the polarisation decreases and becomes less permanent, whilst any layer of a salt of copper which had been formed would be removed.

According to Macaluso, cobalt is depolarised with difficulty in its own salts, which Lippmann ascribes to rapid superficial modifications of the electrodes. Macaluso has not observed such changes, but has obtained very constant results after they have been polished.

The view of Lippmann, that the electric work expended in exciting polarisation is accumulated not in the form of chemical energy but in that of electric energy, as in an accumulator, is not shared by other physicists.—*Wiedemann's Beiblätter.*

THE PILSEN LAMP.—The *Times* correspondent, in speaking of the Paris Electrical Exhibition, thus alludes to this lamp in the issue of November the 17th:—"In my opinion, one of the best lamps in the building for working with a good many on one circuit is the Pilsen lamp. This is shown in the Austrian section, and also by Mr. Fyfe in the British. In both cases it is fed by a Shuckert machine, which is really a Gramme machine, with a flat ring and with field magnets at the sides, as in a Brush machine. I have watched this lamp carefully since the beginning of the exhibition, and have always found its action perfect. At the same time, while being very simple, it is furnished with every device against derangement which can be desired." At the Smoke Abatement Exhibition at South Kensington six of these lamps will be shown by Messrs. Rowatt and Fyfe. We understand that several of these lamps have been employed, with most satisfactory results, for the last six months at the Farningham Paper Factory, and installations have been made both at Glasgow and Dublin. At the forthcoming exhibition at the Crystal Palace ten of these lamps will be shown in action.

THE JOEL LAMP.—This lamp will also be exhibited by Messrs. Rowatt and Fyfe, at the Smoke Abatement Exhibition, where 10 factory lamps will be worked from a Siemens' D^2 machine. At the Crystal Palace 36 of these lamps will be exhibited, and there are now at the Prudential Assurance Company's offices, 18 of these lamps, which have been working most satisfactorily for the past two months, giving the necessary light for 100 clerks at their duties. These replace 90 gas jets, with greatly increased efficiency, and having the great advantage of leaving the atmosphere pure and cool.

THE JABLOCHKOFF LIGHT.—The candles for this system will henceforth be sold at 2d. each.

TENDERS FOR ELECTRIC LIGHT.—The gas committee of the Sevenoaks Local Board are prepared to receive tenders for lighting their streets by electric light. Particulars can be obtained of the Clerk of the Local Board, Sevenoaks, Kent. Tenders to be sent in on or before the 10th December, 1881.

THE BRITISH ELECTRIC LIGHT COMPANY.—It is reported that Professor Forbes is to be Managing Director of this Company, and it is also said that Mr. Ward, the engineer, and Mr. Wills, the secretary, have resigned.

ELECTRIC LIGHTING.—Mr. Finglands' hosiery factory, Hawich, has been successfully lighted with Swan's lamps. Messrs. Roberts & Co., Selkirk, have entered into a contract with an Edinburgh firm for an immediate introduction of the electric light into the Forest and Philiphaugh Mills. Should the experiment prove satisfactory, it is anticipated that the other Tweed mills will follow suit.

THE EDINBURGH TOWN COUNCIL have decided that the Brush Electric Light is not a suitable illuminant for the streets of their city. This decision has been come to, it is said, in consequence of the numerous complaints made regarding the unsatisfactory nature of the light. It has been in use for three months and has cost the ratepayers £838. The Brush Electric Company have offered to supply the light at 2d. per hour per lamp, and the Gas Light Company an improved light for about half the sum. We think the Edinburgh people must be hypercritical, or the installation not so efficiently managed as those by the same company in London.

ELECTRIC LIGHT AND THE FINE ARTS.—The application of the Maxim incandescent electric light to the illumination of the Glasgow Fine Arts galleries has during the past fortnight been practically demonstrated. The opinion expressed is that this light is better for the examination of pictures than the "*arc*" light. We believe that these are the first picture galleries in the kingdom *entirely* lighted by electricity.

THE TELEPHONE ON BOARD SHIP.—A telephonic system worked by Hunning's micro-telephone transmitters, and Harrison, Cox-Walker, & Co.'s (Darlington) receivers, has been introduced on board the screw-steamer *Gloucester City*, a vessel of splendid fit-out, 2,150 tons gross register, which was launched a few weeks ago by Messrs. Richardson, Duck, & Co., of Stockton-on-Tees, and is now taking in her engines and being made ready for sea at Hartlepool. The wires extend from the captain's berth to the chart-house; and there is no difficulty in gaining the ear of the officer on watch posted on the bridge; and the captain, if in the chart-house, can by the same means communicate with the ship's company. The cost, complete, is £17 10s. The same appliances were lately provided on board the *Brooklyn City*.

THE COST OF TELEPHONIC TELEGRAPHY.—According to the figures supplied by Mr. J. W. Batten, a week or two ago, the United Telephone Company passed along its wires 19,522 messages a day for 1,218 subscribers, at a total cost to them of £81, or as nearly as possible one penny per message.

THE UNITED TELEPHONE COMPANY (LIMITED) *v.* ALEXANDER MACLEAN, EDINBURGH.—In the Bill Chamber of Court of Session a process to obtain interdict against alleged infringement of patent for Edison's transmitter and Graham Bell's telephone receiver was heard on November 17 before Lord MacLaren. It was complained that the respondent (Alexander MacLean) who is a telephone contractor in Edinburgh, had infringed these patents by putting up at least nine transmitters and receivers. In the course of discussion it was submitted for respondent that Edison's patent is bad, has been anticipated, is of no public utility, and has not been infringed by respondent. It was admitted that he had infringed Bell's patent, but had discontinued the infringement and undertook not to use the patent in future. In respect of this admission it was submitted that the complainers were entitled so far as regards Bell's patent to interdict and damages.

The Lord Ordinary granted *interim* interdict and passed the note for the Lord Ordinary of the Court of Session to try the other question raised.

A TELEPHONE EXCHANGE has been opened by the National Telephone Company Limited, at Aberdeen. A considerable number of connections have already been made; the captain, pilot, and dockmaster's offices being on probation for a period of twelve months.

THE TELEPHONE IN LANCASHIRE.—By direction of the Postmaster-General, the local postal and telegraph authorities have just completed a double line of wire for telephone purposes between Manchester and Liverpool.

UNDERGROUND TELEGRAPHY IN PHILADELPHIA.—A test of the working of the new line on Market Street of the National Underground Electric Company was made recently at Philadelphia with three telegraphic instruments, two telephones, and an electric lamp. Solenoid wires, consisting of a single insulated wire wound about a similar straight wire, connected them. It is reported by the Philadelphia journals that the experiment proved successful.

UNDERGROUND TELEGRAPHY IN ENGLAND.—It is reported that the engineers of the postal department advise the Postmaster-General that the cost of putting the principal lines underground will be 1¾ millions sterling.

UNDERGROUND TELEGRAPHY IN FRANCE.—Since the recent decision to employ underground wires extensively in France has been announced, the price of gutta-percha insulated wire in that country has risen 35 per cent.

THE "FARADAY."—The s.s. *Faraday* has returned to London completely disabled, one of her screw shafts having broken. To effect the repairs it will be necessary to unship nearly the whole of the cable; a considerable period must consequently elapse before the vessel can again be ready for sea. As a large holder of Anglo-American stock, Mr. Jay Gould may possibly not look upon the accident in the light of a great disaster.

INTERNATIONAL EXHIBITION IN NEW ZEALAND.—An International Exhibition will be opened at Christchurch on March 18 next. A special section will be devoted to the exhibits from Great Britain. Gold, silver, and bronze medals will be awarded. All particulars may be obtained at the International Exhibition Offices (Messrs. J. M. Johnson and Sons, Limited), 1, Castle Street, Holborn.

TELEGRAPHIC CLERKSHIPS IN THE POSTAL TELEGRAPH DEPARTMENT.—An open competition for admission to the Post Office (male) School of Telegraphy (age 14—18) will be held in London on December 19. For particulars and the necessary form of application apply at once to the Secretary, Civil Service Commission, London, S.W.

ROYAL INDIAN ENGINEERING COLLEGE, COOPER'S HILL, STAINES.—This college has been recently placed on a new basis, and the advantages afforded by it as a training institution for those who purpose adopting the civil engineering profession in India or elsewhere are now offered to all persons desirous of following the course of study pursued there. A number of students, not exceeding fifty, will be admitted to the college in September, 1882. Candidates for admission must, on July 1, 1882, be over seventeen and under twenty-one years of age, and must give satisfactory proof of their having received a fair general education. The Secretary of State for India will offer sixteen appointments in the Indian Public Works Department for competition among the students entering the college in September, 1882, at the termination of their prescribed three years' college course, that is, in the summer of 1885. The Secretary of State for India will further offer two appointments in the Indian Telegraph department among the same students after two years' course of study, that is, in the summer of 1884. In the event of there being more candidates for admission than the college can receive, the preference will be given to qualified candidates according to dates of application for admission. For all further particulars apply, by letter only, to the Secretary, Public Works Department, India Office, S.W., or to the President, Royal Indian Engineering College, Cooper's Hill, Staines.

THE SECRECY OF TELEGRAMS.—At Manchester on November 18, a man named Watson was committed to the assizes, charged with inducing a telegraph clerk to reveal to him the contents of sporting telegrams on the 10th inst. The prisoner was seen to pick up a piece of paper, thrown to him out of a window in the telegraph office, and on being examined, it was found to contain information respecting that day's racing at Aintree.

BRITISH ASSOCIATION MEETING AT SOUTHAMPTON.—A meeting of the General Committee for the reception in Southampton, in August next, of the British Association for the Advancement of Science, has been held in that town, under the presidency of the Mayor. An influential local executive committee was appointed, which included the head of the Ordnance Survey Department, and some of the chief medical authorities at Netley Hospital. It was resolved to invite the chief residents of the country on the occasion, and to ask Prince Leopold to become vice-president.

TRANSMISSION OF MONEY BY TELEGRAPH.—The Postmaster-General is of opinion that its introduction is not called for.

THE CENTRAL AND SOUTH AMERICAN CABLES.—The India-Rubber and Gutta-Percha Telegraph Works Company's s.s. *Dacia* left Greenhithe on the morning of Saturday the 19th ult. having on board over 800 miles of cable for the Central and South American Telegraph Company. Stress of weather, however, compelled her to put into Plymouth and she left England finally on the Wednesday after, at daylight. It will be remembered that the s.s. *International* left on the 9th November with a portion of the cable for the above-named company. The loading of the *Dacia* was very remarkable for the speed at which the cable was coiled on board. It seems that the vessel was handed over by the Post-office authorities (who had chartered her for the recent repairs to their cables) on Monday the 7th of November. She was then docked, cleaned, painted, and moored off Silvertown on Thursday morning the 10th, leaving that place on the Tuesday evening following, having shipped the cable at the rate of

165 miles per day. This includes some slight waste of time, owing to a strike amongst the cable coilers. The following are the stations and lengths of cable of this company:—From Vera Cruz to Goatzacoalcos, 90 miles; Goatzacoalcos is connected with Tehuantepec or Salina Cruz by a land line about 220 miles in length; the cable then continues from Salina Cruz to San José de Guatemala, 320 miles; from San José to Salinas Bay, distance 390 miles; from Salinas Bay to Punta Mala at the mouth of Panama Bay, 560 miles; from Punta Mala to Panama Town, 95 miles; from Punta Mala again to Buenaventura, 320 miles; Buenaventura to St. Elena, 500 miles; from St. Elena a branch land line of a 110 miles is run to Guayaquil; St. Elena is then connected by cable to Payta (Peru), 230 miles; the last section of this company's cable being from Payta to Chorillos, 580 miles. At Chorillos (the landing place for Lima) the line joins that already existing and belonging to the West Coast of America Telegraph Company.

The s.s. *Retriever*, the repairing vessel of this latter company, has been chartered to accompany the present expedition, and to thoroughly survey the route over which it is proposed to lay the cables. The India-Rubber and Gutta-Percha Company have sent out an experienced chemist to analyse the nature of the specimens taken from the bottom during sounding operations. We believe this is the first occasion on which such kind of investigations has been undertaken by a cable company, and the management at Silvertown is deserving of all credit for its meritorious endeavours to increase our knowledge of that part of the globe, of which so little is known, viz.—the ocean bed. These operations will be carried out under the direction of Mr. E. W. Parsone, the engineer and manager of the West Coast Company. The *Retriever* is very completely equipped for the purpose of these researches, having on board, besides the usual cable repairing gear, a steam sounding machine (a modification of Sir W. Thomson's wire sounding apparatus). A chemical laboratory is also fitted up on board. The intention is to take some 900 or 1,000 soundings at an average distance apart of four miles; this, of course, does not include a large number which will be taken at closer intervals near the landing places. Up to the present all that has been considered necessary in this direction was to take soundings at intervals of about 30 or 40 miles, and in fact, when the Atlantic cables previous to 1875 were laid, the soundings numbered only 57, over a distance of 1,700 miles. It may here be added that the India-Rubber and Gutta-Percha Company were the first to use Thomson's wire-sounding machine extensively, the first experiment dating from November, 1872; and in 1875, on the same coast, whilst submerging the West Coast of America Company's cables, 460 soundings were taken over a distance of nearly 1,700 miles, exclusive of soundings for landing places.

It will be seen from the foregoing statements with what very great care the operations of this company are carried out in every detail, and we venture to say that the benefits to be derived from such a series of investigations as those mentioned above must be immense, not only to the company conducting them, but also to all who are connected directly or indirectly with shipping and commercial interests in that quarter of the world.

Out of the 3,000 and odd miles of cable ordered by the Central and South American Company, 1,750 miles are already manufactured, and the greatest turn out in one week on this order, not including any of the usual outside work, was 174 miles. In our next issue we shall probably give an account of the various types of cable to be used on this expedition.

THE WEST INDIA AND PANAMA CABLES.—At the Silvertown Works, 300 miles of cable are now being manufactured for this company, 250 miles being deep sea, and 50 miles Cuba type; the engineers are Sir Samuel Canning and Robert Sabine, Esq., C.E.

ACTION AGAINST A CABLE COMPANY.—With reference to the case of Harold *v.* the India-Rubber and Gutta-Percha Company, which we referred to in our last issue, it was remarked that during the proceedings the case was closely watched on behalf of the Telegraph Construction and Maintenance Company, who, we are informed, are interested in the plaintiff's concession to the amount of some £1,500. A similar injunction against the Central and South American Telegraph Company was prayed for in the courts in Philadelphia, but, like the prayer in the English courts, it failed to bring any result.

STORMS.—The past fortnight has been prolific of violent storms of wind and hail, thunder and lightning. The interruption to telegraphic communication within the United Kingdom has again been great, more especially on the west coast of Scotland, where in some places as many as 30 poles were blown down, and the wire swept into the sea. On the evening of the 16th ult. a brilliant display of aurora borealis was witnessed at Dundee, shortly afterwards followed by a violent thunderstorm, the lightning flashes being very vivid and the thunder peals loud and prolonged. On the 22nd November another thunderstorm passed over Scotland, doing considerable damage to property. At Dunphail station on the Highland railway, the telegraph instrument was thrown out of its place; at Greenock, Hillside Cottage was struck, a pilaster which projected about two inches from the face of the wall being torn down and broken in pieces, the stone step broken, and the cupola of the roof carried away. At Tighubruich the flag turret of Glen Caladh House was damaged; great masses of the heavy stone parapet being thrown down, the wood and iron work at its base torn away, and the cast iron water main, which is buried about five feet underground, destroyed. One of the domestics sustained a shock, but quickly recovered.

Correspondence.

TELEGRAPHIC COMMUNICATION WITH LIGHTSHIPS.

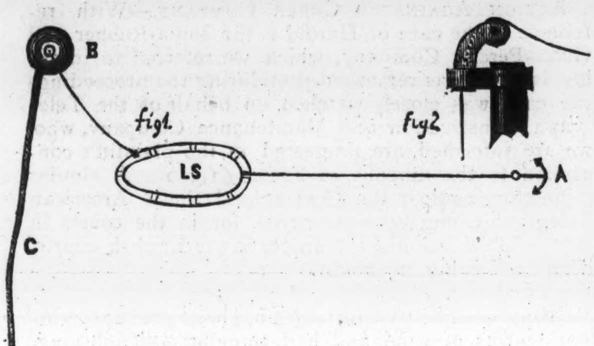
To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I inclose a sketch of an arrangement intended to obviate the difficulty which is at present experienced of maintaining telegraphic communication with lightships, owing to the swinging around the moorings caused by the tide and the occasional lengthening of the mooring cable.

It is proposed to attach the telegraph cable to a buoy held in position by a heavy weight and placed outside the circle in which the ship moves around its moorings, and to complete the connection with the ship by means of a small but strong insulated wire. A sufficient length of this wire is wound upon a drum which has for its axis a rail which completely surrounds the ship. The length of wire may be varied at will and the direction of the cable buoy followed by sliding the drum around the rail. The supports of the latter are in pairs and hinged so that they can be unpinned and turned down one at a time to allow the drum to pass.

In the event of the connection between the cable buoy and the lightship being broken a new wire can be connected in suitable weather.

Where the lightship has but one mast an overhead wire may be employed, passing up a channel in the mast and over a swivel pulley at the top to a short pole on the cable buoy. The length of wire being varied from a drum upon the deck.



In the sketch, L S, fig. 1, is the lightship; C, the telegraph cable; B, the cable buoy; and A, the lightship anchor.

Fig. 2 shows the pulley for the overhead wire.

Yours truly,
F. H.

THE CRYSTAL PALACE ELECTRICAL EXHIBITION.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—The ending of your leader of the 15th leads me to hope that the public may rely on your impartiality in the coming Electric Exhibition—that we shall not find you partial to names and systems, and that, as formerly, you denounced re-inventions, we shall still find you only giving credit to whom it is due. "Electrophiel's" letters in the *Times* lately met with no answer from the "telephone corners," and except your mention of their late purchase, the public hear little of them. Should they get up a Telephone Exchange at the Crystal Palace, and go on claiming everything almost, as heretofore, they may persuade the public that there is but one telephone, and that their own property. Those who were fortunate enough to get the business of the Opera and the Exchange at the Paris Exhibition, got well written up, and have doubtless reaped much profit, and their claim for originality in their instruments allowed by those not conversant with the matter. Such like things I trust you will keep us clear from, and give every one his due.

I am,
Your obedient servant,
23rd Nov., 1881. X.

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

ELECTRICIAN, N. B.—Associates must be of more than 21 years of age, and must be either electrical or telegraph engineers by profession, or must be engaged on responsible electrical or telegraph work; annual subscription, £1 1s. Students must be over 18 and under 21 years of age, and must either be serving a pupilage to an electrical or telegraph engineer, or must be studying natural science; he must be recommended by a member; annual subscription, 10s. 6d. Forms of application for admission to the Society may be obtained from the Secretary, at 8, Broad Sanctuary.

Proceedings of Societies.

THE PHYSICAL SOCIETY—Nov. 12TH.

THE first meeting of the Physical Society for the winter season was held on Saturday, November 12th, Professor FULLER, vice-president, in the chair.

Mr. W. D. Niven was elected a member.

Mr. LEWIS WRIGHT then read a paper "On some Spirals observed in Crystals, illustrating the relation of their Optic Axes." After remarking that the relation of the axes in uni-axial and bi-axial crystals had always been an interesting subject, he observed that if we took any uni-axial and a single axis of any bi-axial which had little or no axial dispersion, and polarised and analysed each circularly, we ultimately got similar phenomena. This is illustrated by calcite and a single axis of sugar, each giving when thus treated, unbroken circular rings. From this it might be hastily inferred that a single axis of a bi-axial resembled in character the axis of a uni-axial. But this was not the view of those who framed the theory of double refraction in crystals. Fresnel finally framed the conception of three elasticities in three rectangular directions. If all were equal there was no double refraction; if only two were equal there was a single optic axis in the direction of the third; and if all were unequal there were two optic axes. According to this theory, the axis of the calcite did *not* resemble in character a single axis of the sugar or other bi-axial, but was a limiting case in which *both* such axes coincided. This was illustrated by the beautiful experiment of Professor Mitscherlich, applying heat to a crystal of selenite, and thereby altering the respective elasticities. The two axes gradually approached until they coincided, and the crystal became uni-axial, after which, on heating the crystal still more the axes re-opened in a direction at right angles to the former, thus proving Fresnel's theory. Sir George Airy had illustrated the point—that the axis of a uni-axial did retain, or still embraced within itself in some visible form, characteristics of the two axes thus brought into coincidence. This was done by his discovery of the double spiral in quartz. Uni-axial calcite showed a double spiral, and bi-axials gave a single spiral. Mr. Wright repeated Professor Mitscherlich's experiment with this additional method of analysis; the spirals being first shown perpendicularly arranged above each other. Gradually they approached, until they resembled those of the calcite, and finally opened out again horizontally. All through there was a double spiral, and a single one could only be got by separating a single axis. The fluid would represent the axial properties of the quartz and the crystal the other properties, and the two ought to give similar spirals. In fact the fluid should replace the quartz successfully in all these experiments. By means of a column of oil of lemons, 200 millimetres in length, and crystals of calcite, sugar, topaz, and nitre, Mr. Wright showed this to be the case. Finally, he demonstrated that the same phenomena held good through all the ordinary analogies with, or artificial substitutes for, natural crystals; the figures being produced with a circular chilled glass in parallel light, and also with an artificial uni-axial crystal, made of crossed mica films, after Norremberg, and an artificial quartz made of superimposed mica films, after Reusch, in convergent light. All the figures were projected by the electric camera to a size 8 ft. in diameter. All Mr. Wright's experiments went to illustrate the truth of Fresnel's theory.

Mr. C. V. BOYS then read a paper "On the Prevention of the Bursting of Water Pipes." Mr. Powell had proposed the use of pipes of elliptical or other round section, and Mr. Mangnall, of Manchester, had independently suggested the same idea. Such a pipe would become rounder in section when the water froze and expanded. A round pipe tends to become thinner at its weak parts, on expanding under the pressure. With an elliptical pipe the force required to alter the shape of its section is greater as the section is more circular, therefore the effect produced by a change of shape at any place makes that place stronger. A round pipe is in a state of unstable, and an elliptical pipe in a state of stable equilibrium, and changes its form uniformly from end to end. Hence, if a portion only of such a pipe is exposed to the cold, the whole is effective, and it will require a proportionally greater number of frosts to make the pipe round. Inspection would show if the pipes were becoming round, and then they could be squeezed back to their original shape. Mr. Boys had demonstrated these inferences by experiment with Mr. Powell. Messrs. Powell, Rigby & Co., of Piccadilly, made these pipes.

Mr. I. MACFARLANE GRAY drew attention to some apparent discrepancies in the constants employed by Regnault in his work on the "Physical properties of steam."

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

AT an ordinary general meeting of this Society, held November 24th, Professor CAREY FOSTER, president, in the chair, a paper on "THE PARIS ELECTRICAL EXHIBITION" was read by Sir CHARLES BRIGHT and Professor D. E. HUGHES, F.R.S., two of the commissioners appointed by Government to represent British interests at the exhibition. A narration was given of the work done by the Society in the first instance, by which the British section of exhibitors were brought together, and the proportionate amount of awards of diplomas and medals given to them was stated as being highly creditable to the country. A special diploma, the only one of its kind accorded to any society in Great Britain, had been granted by the juries to the Society of Telegraph Engineers and of Electricians for their labours in promoting the success of the exhibition.

The most salient features of the exhibition were then described, comprising the generation of electricity, its transmission, and its various applications. Among the latter may be specially enumerated telegraphy and submarine cables, telephony, microphones, lighting, galvanoplastics, fire alarms, clock regulating and meteorological registers, observatory work, and military and naval operations in torpedoes, lighting and signalling, together with ballistic experiments. The transmission of force to a distance and its storage, with many other practical applications to the arts and industrial purposes, with the instructive exhibits of different countries under these heads, were described in the same systematic manner as a visitor might have seen them under the guidance of an expert in electrical science.

In the discussion which followed the reading of the paper—

Professor ABEL commented on the display there of the applications of electricity to military purposes by foreign countries, and said that the English *matériel* in this department would have stood pre-eminent if the Government had permitted its exhibition.

Major FLOOD PAGE stated that with only a few exceptions the whole of the exhibits mentioned in the report would be displayed at the forthcoming Crystal Palace Exhibition, and that the arrangement of the electric lights would be such as to show each system to an equal advantage.

Mr. STROH, Mr. E. GRAVES, Mr. FLETCHER MOULTON, and Mr. FOSTER also took part in the discussion.

A special vote of thanks to the authors was carried, not merely for their paper, but for the eminent services which they had as commissioners rendered to the English section. The services of the honorary foreign secretary, M. Aylmer, were also highly eulogised, and some of the exhibitors present expressed a wish that the services should be acknowledged in a more substantial form. The meeting then adjourned.

THE SOCIETY OF ARTS.

AT an ordinary general meeting of this society held Nov. 23rd, a paper was read by PROFESSOR SILVANUS THOMPSON on "THE STORAGE OF ELECTRICITY." Professor Thompson commenced his discourse by pointing out that the reversibility in action of the voltaic cell is the counterpart and complement of the reversability of the Gramme machine; and while the one has solved the problem of the electric transmission of power, the other has solved the problem of the electric storage of energy. The electric storage of energy must not be mistaken for the storage of electricity itself. A century ago, it was thought that the Leyden jar provided a means of bottling-up electricity itself. In one sense this may be true, though the fact remains, that the more carefully we hunt for the charge of electricity condensed in the jar, the more difficult does it become to realise that there is anything there; and it is doubly difficult to find, in the electric accumulator or storage cell, anything which can be called stored electricity. In electric accumulators, such as those of Planté and of Faure, electric currents are made to do a certain kind of work, which store of work can again yield us currents of electricity. But as a matter of fact, the particular kind of work done is quite as much chemical as electrical.

The reversibility of the Gramme machine affords a means of electric, or rather of electro-mechanical storage. Suppose we want to store electric currents. Set them to drive a Gramme machine, and let the Gramme machine, by means of a pulley, gradually wind up a very heavy weight. If, subsequently, we let the weight descend, it will drive the Gramme machine, and will generate currents as it runs down.

In overcoming polarisation force we do the work of storage. We do electro-chemical work by overcoming electro-chemical forces, just as we do mechanical work by overcoming mechanical forces.

LAWS OF POLARISATION.

To tear away an atom of any element from its compound with an atom of another element, requires the use of a definite amount of electricity, and necessitates further that this electricity should be urged forward with at least a certain minimum electromotive force. Take for example the case of the decomposition of water by the electric current. To tear away a single gramme of hydrogen from the oxygen with which it is combined requires no less than 95·050 webers ("coulombs") to flow through. But these liberated and separated gases are in one sense a store of energy, and would, if allowed to combine together (by burning), produce heat. Their "affinity" for one another is very great, and the electric current has to do a considerable amount of work in tearing these two kinds of atoms away from one another. To see what this work amounts to, let us inquire how many units of heat they would evolve in burning. Careful measurements by Favre, Andrews, and Julius Thomsen, show that 34,000 calories of heat would result. Now the work done to separate the gases is of course equal to the work they would do by rushing together. The affinity of the gases manifests itself as a reaction against the electromotive force of the current employed to separate them. This reaction is itself a counter-electromotive force. When we overcome an opposing electromotive force by pushing a certain quantity of electricity from one point to another against its reaction, we do work just as truly as when we overcome an opposing mechanical force by pushing a certain lump of matter from one point to another against its resistance. In the particular case of the decomposition of water, the opposing electromotive force of polarisation has a magnitude when expressed in the proper units of 1·493 volts. It is possible, when we know how much heat would be evolved by the combination of an equivalent of any substance with oxygen, to calculate the value of the electromotive force that would have to be applied to tear away that substance from its combination with oxygen. Or, again, suppose we know that of two elements one will, when combining with its equivalent of oxygen, give out more heat than another, then we know that it has a greater affinity for oxygen, and, from the difference between their "heats of combination," we can calculate the surplus of electromotive force that we should have to apply to tear away one of these two from oxygen, and to put the other in its place.

In the accompanying table are given, firstly, the equivalent heat values of the various metals when

TABLE OF ELECTROMOTIVE FORCE AS CALCULATED FROM THE HEAT OF OXIDATION OF THE CHEMICAL EQUIVALENT (H = 1 GRAMME), AND AS OBSERVED BY DIRECT EXPERIMENT.

Name of Substance.	Heat Value.	E. M. F.	Electromotive Force observed in Dilute Sulphuric Acid.				
	Calories.	Volts.	With Oxygen.	With Platinum.	With Ozone.	With Peroxide of Lead.	With Zinc.
Potassium	69,800	3·04	...	3·17 (Bf.) 2·484 (Wh.)	...	3·528 (Wh.)	— 1·144 (Wh.)
Sodium	67,800	2·95	...	...	...	...	...
Zinc	42,700	1·862	1·873	1·546 (Po.) 1·439 (Wh.) 1·67 (Bz.) 0·637 (R.)	...	2·448 (Wh.) 2·98 (J.)	O
Iron	34,120	1·570	...	...	...	...	[0·600 (A. & P.)]
Hydrogen	34,100	1·493	? 1·64 (Ta.)	0·86 (R.) 0·877 (Bz.)	1·9 (R.) 2·1 (Wh. Po. Sv.) 2·3 (Bf. Ta.) 2·265 (Ba. Bz.)	? 2·78 (Pl.)	...
Lead	25,100	1·133	...	...	...	2·38 (Pl.)	0·21 (A. & P.) 0·55 (D. L. R.)
Copper	18,760	0·818	0·74 (R.)	0·550 (R.)	...	...	0·953 (Po.) 1·079 (L. C.) 0·978 (L. C.) [0·75 (A. & P.)]
Silver	? 9,000	...	...	...	...	...	
Platinum	7,500	0·327	...	O	1·21 (R.) 1·04 (R.)	0·6 (R.) 0·75 (R.) 0·90 (Wh.)	1·546 (Po.) [1·439 (Wh.) 1·67 (Bz.) [0·981 (A. & P.)]
Carbon	? 2,000	...	...	...	1·435 (L. Swj.) 1·18 (R.)	...	[1·096 (A. & P.)]
Oxygen	O	O	O	...	...	...	...
Nitric Peroxide	— 6,000	— 0·29	...	...	...	...	1·97 (Bf.) 1·95 (L. C.) 1·90 (Sb.)
Chromic Peroxide	— 7,195	— 0·31	...	...	...	...	2·028 (Sb.)
Manganese Peroxide	...	...	...	— 0·54 (Wh.) — 0·101 (R.) — 0·128 (R.) — 0·404	...	0·504 (Wh.) 0.420 (J.)	1·944 (Wh.) 2·55 (J.)
Lead Peroxide	...	...	...	— 0·6 (R.) — 0·75 (R.) — 0·90 (Wh.)	...	O	2·448 (Wh.) 2·98 (J.) 2·1 (D'A.)
Silver Peroxide	...	...	...	— 0·7 (R.) — 0·86 (R.)	...	...	...
Hydrogen Peroxide	— 10,800	— 0·47	...	...	...	...	...
Ozone	— 14,800	— 0·645	...	— 1·04 (R.) — 1·21 (R.)	O	...	...

D'A., D'Arsonval; Ba., Bartoli; Bf., Buff; Bz., Beetz; L. C., Latimer Clark; D. L. R., De la Rue; J., Joule; L., Lenz; Pl., Planté; Po., Poggendorff; R., Raoult; Sb., Sabine; Sv., Svanberg; Swj., Saweljew; Ta., Tait; Wh., Wheatstone; A. & P., Ayrton and Perry (whose observations, being made with an electrometer for contact in air, are placed in square brackets, as not being, like the rest, observations on the electromotive force in sulphuric acid.

oxydised and dissolved in sulphuric acid. In the second column are given the electromotive forces that would be needful to tear away these elements from oxygen, or with which they tend to unite with oxygen—the value, in fact, of the electromotive force which measures electrically the chemical affinity of each of these elements for oxygen.

The order in which these metals are arranged is, in fact, nothing else than the order of oxidisability of the metals (in the presence of dilute sulphuric acid); for that metal tends most to oxidise which can, by oxidising, give out the most energy.

REACTION OF PEROXIDES.

In the preceding discussion, oxygen has been taken as the standard electro-negative substance. But in point of fact there are substances more highly electro-negative; that is to say, substances which when made to combine with a metal such as zinc would give out together a larger amount of heat than zinc does with oxygen. Chief amongst those substances are chlorine and the haloids, the peroxides of the metals manganese, lead and silver, such peroxidised bodies as chromic, perchloric, and permanganic acids, the peroxide of hydrogen, and ozone. If, for example, zinc be caused to combine with an equivalent of peroxide of lead, more heat is evolved than by the mere oxidation of zinc by free oxygen gas. It is clear then that in the unstable chemical aggregation of the peroxide we have a store of energy which can be utilised in giving us voltaic cells of still higher electromotive force. The highly electro-negative (or oxidising) property of the brown peroxide of lead was discovered in 1835 by Munck, of Rosenschöld, who describes it as being the most highly electro-negative substance known, being superior even to the peroxide of manganese which Volta found so highly electro-negative. The peroxide of silver is still more highly electro-negative.

MINIMUM ELECTROMOTIVE FORCE FOR CHARGING.

The electromotive force of polarisation in a cell, evoked there by the passage of a primary current through it, will depend upon what chemical substances are produced at the two electrodes by the passage of the current. In the case of all ordinary liquids and metallic solutions, the products are known.

For each electrolyte there is a minimum electromotive force, without which, complete decomposition cannot occur. For water, for example, this minimum is 1·493 volts. If the current be of less electromotive force than this minimum, the action may begin, but the charging current will be stopped the moment the opposing electromotive force of polarisation has risen to an equal amount. It is for this reason that in charging a Planté cell, or a Faure cell, we must use at least two cells of Grove's or of Bunsen's battery, or at least three cells of Daniell's battery.

The chemical work that is done in any secondary battery, or electrolytic cell, is proportional to the strength of the charging currents, to the time it lasts, and to the effective minimum electromotive force of polarisation in the cell itself. It is not increased by increasing the electromotive force of the charging current much beyond this value; for though a higher counter-electromotive force may be temporarily called out, the work done against this added opposition is wasted in local heat, which is detrimental to the power of the cell. The cells should be charged with only just sufficient electromotive force to overcome their reaction. To charge a Planté cell, two Bunsen cells—not twenty—should be used. The storage will be slower, it is true, but it will be more economical, by far.

STORAGE POWER LESSENED BY HEAT.

Heat diminishes the counter-electromotive force of the cells during charging; it therefore diminishes the amount of chemical work done in charging them, and diminishes the amount of charge thereby stored. Secondary batteries should be kept as cool as possible during charging. A simple experiment in proof of the diminution of polarisation by rise of temperature is the following. Let a single Grove's cell be connected with a water-voltameter: no gases are evolved until the volta meter is heated to near boiling, when the gases come off freely. Bartoli examined the electromotive force of polarisation in a cell containing sulphuric acid with electrodes of platinum, and found it to be twice as great when the liquid was at 5° C as when raised to its boiling point. Beetz and Robinson have independently investigated the same effect, and their results agree precisely. Beetz found the polarisation 2·216 volts at the ordinary temperature of 20° C, and as the temperature was raised it fell off, gently at first, more rapidly afterwards, till at 100° C it was only 1·904 volts.

Temperature.	E.M.F. (Beetz.)	E.M.F. (Robinson.)
16° C	2·216	...
20°	...	2·216
30°	...	2·194
43°	...	2·148
53°	...	2·105
57·5°	2·101	...
60°	...	2·095
80°	...	2·040
94°	1·960	...
100°	...	1·904

IMPORTANCE OF SUFFICIENT CURRENT DENSITY.

The influence on the polarisation force of a cell of the size of the plates used as electrodes relatively to the strength of the charging current has also been investigated by several experimenters, amongst them Crova, Poggendorff, and Bunsen, and more recently by Bartoli and Blondlot. It is found that the degree to which a counter electromotive force or polarisation force is set up depends very greatly on the quantity of current per unit of surface of the electrodes employed. If the current be weak, and the electrodes large, the polarisation never reaches its maximum. On the other hand, if the electrodes be very small surface, and the current a strong one, the polarisation may attain abnormally high values. Thus Buff, electrolysing water with small platinum points, found the counter electromotive force to be no less than 3·57 volts. This difference between this and the minimum value of about 1·493, must be accounted for by the fact that the state of the liberated products varies with the condition of liberation. With greater "current density" the gases liberated by decomposing water are no longer simple oxygen and simple hydrogen. With greater current density, a greater proportion of the oxygen comes off in the more highly electro-negative condition of ozone, and more peroxide of hydrogen forms also round the anode, whilst at the cathode, the hydrogen which is evolved possesses in unusual degree the active properties attributed by chemists to "nascent" hydrogen; that is to say, a larger proportion of it probably is, at the moment of liberation, in some abnormal allotropic condition, bearing the same kind of relation to ordinary hydrogen as ozone bears to oxygen. The allotropic hydrogen is more oxidisable; the ozone more ready to oxidise. Their union would evolve more heat than the union of equal weights of ordinary hydrogen, and ordinary oxygen. It requires greater electromotive force to keep them apart; their own tendency to unite is greater. J. Thomsen has even measured the heat value of ozone as compared with oxygen, and it takes its place in our table of elements at the bottom, below the peroxides, though chlorine and the haloids would be still lower on the list if they came within the scope of present considerations.

It follows from the above argument, that if we wish to make our storing cells exert their highest possible reaction, we must store them, using a current whose strength (or quantity) is proportioned to the size of the cell. If we use too weak a current, the maximum polarisation, and therefore the maximum efficiency, will never be attained. This is one of the rocks on which amateur constructors of storage batteries have come to grief. The current density is a most important consideration, especially in the early stages of the formation of the cells. It certainly should not be less than 50 milliwebers per square centimetre of surface in the cell.

EFFECT OF STATE OF SURFACE.

Again, the state of the surface of the electrodes has much to do in determining the state in which the gases are liberated, and the resulting polarisation force. Svanberg, in electrolysing water with copper electrodes, found the polarisation to be ·72 volts with smooth plates, and only ·47 with corrugated plates. Poggendorff, using platinum plates, found the maximum polarisation to be—with bright surfaces, from 2·28 to 2·50 volts; while with surfaces platinised, *i.e.*, coated with a black, powdery deposit of platinum, the polarisation in cells, like those of Planté and Faure, where the original surfaces of the plates of lead are coated with thick films of peroxide, or of reduced metal, these considerations do not apply, except for the first operation of charging. Indeed, I have found, experimentally, that there is a gain in scratching the leaden surfaces, before forming the coating of peroxide; the coating is more adherent, and the effective surface somewhat greater; advantages beside which the greater preliminary waste of liberated gases on first charging is comparatively trivial.

HISTORICAL SUMMARY.

Within one year after the discovery of the pile by Volta, two very important observations had been made. Nicholson and Carlisle, in 1800, discovered that the current so produced could decompose water;* and in 1801 Gautherot discovered that the wires of platinum or of silver which had been employed to thus decompose salt water acquired, and retained after being detached from the pile, the power of yielding a transient current, as could be proved by their efficacy in causing muscular contractions in a frog's leg, and in yielding the so-called galvanic taste. This is the phenomenon afterwards denominated "the polarisation of the electrodes." It was found to consist in a peculiar state of the electrodes which manifested its presence, even before the exciting current of the pile was cut off, by producing an enfeebling reaction against that current, the polarisation current being in a direction which opposed the exciting current. The phenomenon is well known to all electricians, and occurs not only in electrolytic cells, but in the cells of the voltaic batteries, where the liberation of hydrogen bubbles is accompanied by an opposing reaction of the same kind. Indeed, the difficulty with batteries has been to get rid of the polarisation.

In 1803, Ritter, of Jena, re-observed the same phenomenon, using wires of gold; and perceiving the importance of this reaction, he constructed a secondary secondary pile which we will presently describe.

The phenomena of the secondary currents due to polarisation were further investigated by Volta, Marianini, Davy, Grotthuss, De la Rive, Sinsteden, Becquerel, Schœnbein, Matteucci, Grove, Faraday, Buff, Beetz, and others. Matteucci and Grove in particular studied the reaction-currents set up by the presence of uncombined gases at the electrodes, and the latter constructed a well-known "gas battery." In 1869 M. Gaston Planté brought out a secondary battery constructed of lead-plates dipping into sulphuric acid, and in a remarkable and valuable series of classical researches he investigated the phenomena of their action. More recently, modifications of the Planté accumulator have been suggested by M. Camille Faure and M. A. de Méritens. These various systems will be described in detail presently. Professors E. J. Houston and Elihu Thomson, of Philadelphia, have made the suggestion which embodies the principle of reversibility in the case of the Daniell's cell. They place two horizontal copper plates in a cell containing sulphate of zinc in strong solution. To charge this cell, a current is sent through it from the top plate downwards. The upper plate or anode dissolves, forming a solution of sulphate of copper, which, being specifically lighter, floats on the sulphate of zinc. On the lower plate, metallic zinc is deposited; so that, when charged, this battery is merely a "gravity Daniell" battery. It will afterwards yield a current so long as there remains any zinc in the metallic state, or so long as there exists a chemical difference between the two electrodes. This suggestion has been modified by M. d'Arsonval, who uses an electrode of lead, or of carbon covered with lead shot along with an electrode of zinc in sulphate of zinc. In this case, when the cell is charged, zinc is deposited upon the zinc plate, while the lead becomes peroxidised.

Other suggestions have come still more recently from M. J. Rousse, who proposes the use of ferro-maganese, and of palladium as electrodes. The advantages offered by the former alloy over zinc do not appear to be great; and the cost of the latter metal is so enormous as to render suggestion valueless for practical ends.

RITTER'S SECONDARY PILE.

Ritter discovered the possibility of secondary voltaic action while studying the chemical action of electric currents upon liquids. He employed a large voltaic pile as his source of electricity, and observed, not only the decomposition of water into oxygen and hydrogen, but the phenomena of formation of peroxides, and of the deposition of metallic films at the anode and kathode respectively, when metallic solutions were employed. He found that his gold wires, after becoming covered respectively with film, if separated, oxygen and hydrogen could set up violent contractions in a frog's leg. He further investigated the phenomenon with different kinds of wires, and found platinum to yield the best result, gold coming next in order, then silver, copper, and bismuth. With lead, zinc, and tin, however, he obtained no result. He further showed that even after having been removed from the water and dried, the pair of gold wires retained their activity, and when afterwards plunged into water yielded a current in a direction opposed to that of the pile, by which they were originally rendered active.

One remarkable experiment of Ritter's found its way into English journals. Ritter took a *louis d'or*, and placing moistened cloth against its two sides, proceeded to pass through this combination a current from a powerful pile. The coin still laid in its wrappings was afterwards found capable of furnishing a current. This led Ritter to propound the view that conductors of electricity, such as the metals, could be charged with electricity; the coin between its metal wrappings being, according to him, analogous to the Leyden jar lying between its two coatings of tinfoil. He mentions also mercury, carbon, graphite, and binoxide of manganese, as being capable of receiving galvanic charges.

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* Water had previously been decomposed by discharges from an electric machine in 1789, by Paetz van Troostwyk and John Cuthbertson.

To produce the effects of galvanic charge upon a large scale, Ritter constructed a secondary pile *(Ladungs-Saüle)*, consisting of a series of discs, of one metal—copper; separated by pads of cloth, moistened with a solution of salt, or sal ammoniac.

(To be continued.)

New Patents—1881.

4850. "Incandescent electric lamps." C. J. ALLPORT and R. PUNSHON. Dated November 5.

4854. "Improved means and apparatus, or appliances connected with the production, the storage, and utilisation of electricity for lighting or power purposes." J. B. ROGERS. Dated November 5.

4855. "Electric lamps." J. B. ROGERS. Dated November 5.

4866. "Voltaic or galvanic batteries." T. COAD. Dated November 7.

4867. "A new or improved cabinet for voltaic or galvanic batteries." T. COAD. Dated November 7.

4882. "Electric time-pieces. W. P. THOMPSON. (Communicated by A. Lemoine.) Dated November 8.

4883. "A new or improved electro-pneumatic apparatus for winding and regulating clocks." M. BAUER. (Communicated by C. A. Mayrhofer and W. Otto.) Dated November 8.

4885. "Improved means of insulating and protecting underground electric lighting wires and cables, and in water-tight boxes for the ends of such wires." W. C. JOHNSON and S. E. PHILLIPS. Dated Nov. 8.

4905. "Apparatus for the transmission and reception of sounds." W. C. BARNEY. Dated November 9.

4939. "Apparatus for producing light by means of electricity." A. F. ST GEORGE. Dated November 11.

4942. "Application of electric currents to the production of light." S. PITT. (Communicated by L. Goulard and J. D. Gibbs.) Dated November 11.

4948. "Electric lamps." G. G. ANDRE. Dated November 11.

4851. "An improved electro-motive engine." D. T. PIOT. Dated November 5.

5002. "Improvements applicable to dynamo-electric circuits." S. VYLE. Dated November 15.

5006. "A new or improved method and apparatus for regulating the production of electricity by dynamo-electric machines." F. WRIGHT and F. A. ORMISTON. Dated November 15.

5026. "Telephone receivers." F. H. W. HIGGINS. Dated November 16.

5028. "Telephone receivers." R. and M. THEILER. Dated November 16.

5050. "Improvements in apparatus for automatically transmitting and receiving signals for denoting places at which attempted burglaries and robberies may be made, and for other purposes." F. R. FRANCIS. Dated November 18.

5070. "A telephonic repeater." C. MOSELEY. Dated November 19.

5071. "Improvements in and connected with telephonic transmitting apparatus specially adapted for pantelephones." E. de PASS. (Communicated by L. de Locht-Labye.) Dated November 19.

5080. "Apparatus for the conduction and distribution of electric currents." R. E. B. CROMPTON. Dated November 21.

5096. "Electrical commutators." W. R. LAKE. (Communicated by F. Blake.) Dated November 22.

5104. "Electric batteries." A. M. CLARK. (Communicated by G. Fournier.) Dated November 22.

5126. "A new hermetical voltaic pile. R. H. BRANDON. (Communicated by C. A. Nyström.) Dated November 23.

5140. "Telephonic and telegraphic signalling apparatus." A. C. BROWN and H. A. C. SAUNDERS. Dated November 24.

5159. "Galvanic batteries and electro-chemical accumulators." R. E. B. CROMPTON and D. G. FITZGERALD. Dated November 25.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

1393. "Electric drills." J. H. THOMSON. Dated 29th March. 2d. Relates to drilling machines operated by electricity, and which are specially adapted for use as portable drilling machines to be held up to the work by hand. (*Provisional only.*)

1412. "Manufacture of carbons for incandescent electric lamps." J. SCOTT and W. H. AKESTER. Dated March 31. 2d. The carbon filament is manufactured from the fibre which is used for the manufacture of brushes, and which is called in the trade "kitool." This fibre is coiled to any desired shape, and dried and heated so as to set it in that shape, it is then carbonised by exposure to high heat in a close vessel without access of air. The fibre is surrounded before and during carbonisation with fine sand or powdered charcoal, or other suitable material, so as to retain it in its position and prevent warping, and protect it from injury.

1422. "Production of electric light." WILLIAM CROOKES, F.R.S. Dated March 31. 4d. Relates to the preparation of the carbon for incandescence or arc lamps and also to the preparation of the glass inclosures for incandenscence lamps. The fibre or carbon is soaked in hydrofluoric acid, or in some chemical mixture equivalent thereto, or it is exposed to the vapour of hydrofluoric acid. After being soaked for some time the fibre is well washed in pure water till free from acid. The vegetable fibre, cotton, paper, thread, and the carbon made therefrom, treated in this manner has little or no ash when burnt. In the preparation of the vacuous inclosures for the display of electric light, copper or iron leading in wires are used instead of the usual platinum ones, and to avoid the difficulty from the difference between their rates of expansion and that of glass, they are coated with an enamel having an intermediate rate of expansion. In exhausting the glass vessel, there is introduced in the latter an earthy metallic or other body having great affinity for aqueous vapour or other gas, and capable of absorbing and holding it in a high vacuum and evolving it when heated. The vessel is exhausted to a moderate degree, then the earthy or other body is heated to drive off the occluded gas or vapour; the vessel is then re-exhausted. As the earthy or other body cools it absorbs the gas which it formerly gave out and produces an exhaustion higher than can be obtained in the ordinary method of pumping by the mercury pump.

1442. "Electric batteries." **Felician Rola de Wolski.** Dated April 1. 2d. The object of this invention is to reduce the internal or fluid resistance of the cells of electric batteries, to increase their electromotive force, to diminish local action, to render more constant both the electromotive force and the resistance of such cells, and thus to increase their efficiency, and diminish the cost of working. This is done by limiting the electric action to the opposing surfaces of the plates forming the electrodes of the cells, the reverse surface of either or both plates being rendered inactive, either by being coated with an insulating material, or by so arranging the elements in the cell as to render inactive the reverse surface of either or both plates. (*Provisional only.*)

1447. "Electric machines." **Charles William Siemens.** (A communication from abroad by Messrs. Siemens and Halske, of Berlin.) Dated 1st April. 6d. Has for its object the construction of dynamo-electric or magneto-electric or electro-dynamic machines in such manner as to afford a continuous electrical current both as regards direction and practically also as regards strength. The essential feature of the invention is the combination to form a continuous current of separate electrical impulses that are generated immediately after one another at different parts of the machine; in machines hitherto constructed such combination can only be effected in impulses generated in consecutive magnetic fields.

fig.1.

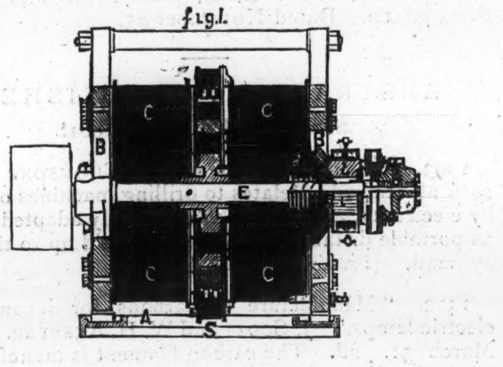


fig.3.

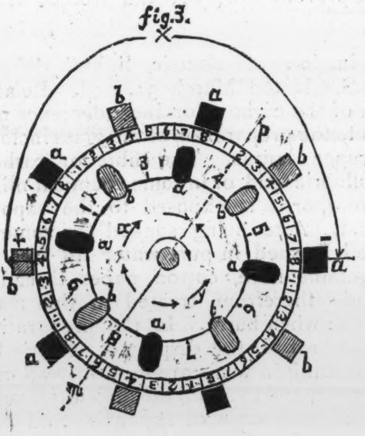


fig.4.

fig.7

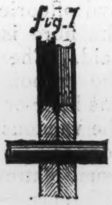


fig.6

fig.5

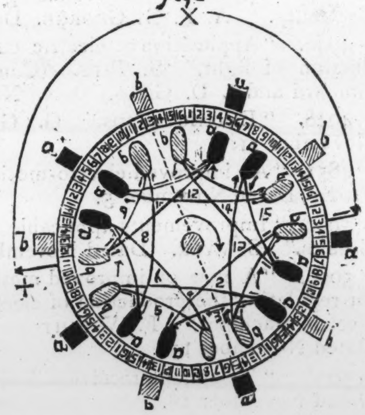
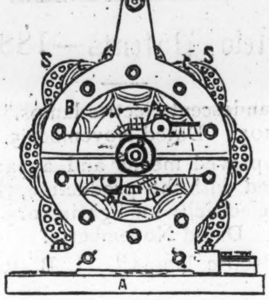


Fig. 1 is a longitudinal section, and fig. 2 is a front or end view of a machine for the production of intermittent currents of like or of alternate direction. On the base, A, are fixed two parallel sideframes, B, B, of circular form. On the inner faces of these frames are fixed projecting inwards from them, an even number (in this case 10) of electro-magnets, C. The inner ends of these magnets facing each other have polar extensions of suitable segmental form, and the polarity of each is opposite that of the pole of the magnet facing it, and of the poles of the magnets on each side of it, so that between each pair of tacing poles there is a powerful magnetic field of polarity opposite to that of the field on each side of it. Through these magnetic fields are caused to revolve bobbins, S, S, of insulated wire, wound on wooden cores of elongated shape, these bobbins being fixed on a wheel on the axis E, and being of such width as almost to touch the poles of the magnets, C, on each side of them. If when the number of coils, S, is the same as that of the magnets, C, as in machines hitherto employed, then all the coils have currents induced in them simultaneously as they approach, and leave the successive polar fields. According to the present invention however the number of coils, S, is made to differ by an even number from that of the fields, G, through which they pass; in the example given in figs. 1 and 2, there are 8 coils passing through 10 fields. The effect of this is that every pair of diametrically opposite coils is always in the same phase of induction, each successive pair being subject to a greater or less inductive influence, as the case may be, Thus the current does not, as in previous machines. attain its maximum or minimum strength in all the coils simultaneously, but successively in each pair of diametrically opposite coils. The wires of all the coils being so connected as to form a continuous circuit whilst they are wound on the coils alternately in opposite directions, the impulses in all the coils become added together. The axis of the machine carries a

fig.2.



commutator, *t*, of ordinary construction, consisting, in the example given, of 40 insulated plates divided into 5 groups, each consisting of 8 commutator plates, each plate separated from the next of its own group by 7 intermediate plates. This grouping is effected by means of 8 insulated rings, *r*, fixed on the axis, to each of which 5 of the commutator plates are connected by 5 wires, *d*, and the rings, *r*, being connected each to the wire connecting 2 successive coils, the successive groups of commutator plates correspond in order with the successive connections of the coils. The currents are collected in the usual way by 2 opposite brushes which can be shifted more or less round the periphery of the commutator. The action of the machine may be more clearly understood on reference to the diagram, fig. 3, in which the outer squares, *a*, *b*, represent the 10 stationary fields of alternating polarity, and the inner ellipses, *a*, *b*, represent the 8 coils that revolve through them. The divided circle between these represents the commutator, having its 40 plates arranged in 5 groups, each containing 8 plates numbered respectively from 1 to 8. The numbers 1, 2, 3, etc., between the ellipses indicate the wires that lead from the connecting wire of each pair of adjoining coils to the rings, *r*, and thence to the commutator plates. Thus the wire, 1, is connected through its ring with all the 5 commutator plates marked 3, wire 2, with all the 5 plates marked 8, and so on. The arrows marked respectively + and — indicate the commutator brushes. It will now be understood that all the coils which are approaching fields marked with the same letters, *a* approaching *b*, and *b* approaching *a*, have currents set up in them in one direction which may be indicated by the arrows, *x*, and that all the coils approaching fields marked by different letters, *a* approaching *b*, or *b* approaching *a*, have currents set up of opposite direction, which may be indicated by the arrows, *y*. There will always therefore be in every situation of the coils as they revolve, a diametrically dividing line such as *p*, *m*, towards one end of which there is an accumulation of positive and towards the other of negative electricity. This line in the position shown in fig. 3, passes through the junctions 4 and 8, and as the brushes rub on the corresponding plates 4 and 8 of the commutator they take off the accumulated electricity. The imaginary line, *p*, *m*, always moves round in a direction opposite to that of the commutator and with greater velocity. For example, when the coils and commutator have moved $\frac{1}{40}$th of a revolution, the line *p*, *m*, will pass through the junctions 3 and 7, and thus the brushes are always in the proper position to receive the currents, which will obviously be the more nearly uniform the greater the number of fields and coils employed. Assuming n to be the number of coils, and $n + 2$ the number of fields, then $\frac{n}{2}(n + 2)$, or $n\left(\frac{n}{2} + 1\right)$ will be the number of commutator plates, such that there is always a pair of opposite plates corresponding to an opposite pair of connections between two successive coils. The number of fields might be less than the number of coils, that is to say, if the coils number n, the fields might number $n - 2$. Again, the number of coils might be doubled by arranging them in two planes overlapping each other, as shown by figs. 6 and 7, the connections being in that case arranged as shown by the diagram, fig. 5, in which the arrows indicate the directions of the currents to and from the several coils, and the numbers marked on the lines connecting the coils indicate the connections through the rings to the respective commutator plates, which in this case number 80, divided into 5 groups, each containing 16.

Instead of collecting the currents from a number of coils together as described, each separate coil might be arranged to deliver its current, and these currents which would be alternating might by means of known commutators be directed as successive currents, and collected into currents of constant direction; fig. 4 shows in perspective a single coil with a commutator arranged for this purpose. A number of such commutators might be arranged on the axis of the machine, and their respective brushes, *f*, *f*, connected as desired.

The claims made under this patent are as follows:—

First. Combining with an even number of stationary magnetic fields of alternating polarity, a number of revolving alternately wound coils differing by two or other even number from the number of fields, the wires of the coils being all connected to one another and to a commutator, substantially as and for the purposes herein set forth.

Second. In a machine arranged in the manner referred to in the preceding claim, the use of a commutator the plates of which are combined in groups, each containing as many plates as there are revolving coils, substantially as and for the purposes herein set forth.

1474. "Apparatus for laying underground telegraphic or telephonic conductors." J. C. Mewburn. (A communication from abroad by Bourdin, and General Serge Ivanowitch de Maltzoff, of Paris. Dated April 5. 2d. The object of this invention is to construct an apparatus by means of which underground conductors can be very rapidly and economically laid. The new or improved apparatus is composed of a sort of carriage carrying a reel upon which the conductor to be laid is wound, and a share, somewhat resembling that of a draining plough, the nose or point of which makes the channel for the conductor, and the body of which has a hole through which the conductor as it unwinds from the reel passes, issuing at the rear of the share into the bed which the nose has prepared for it. (*Provisional only.*)

1526. "Electric lamps, &c." J. D. F. Andrews. Dated April 7. 6d. Fig. 1 shows one form of the lamp; *a* and *b* are two carbon discs fixed parallel to each other at a little distance apart, one of these carbons, *a*, having a countersunk central hole, *c*, and being connected to the conductors at its outer edge, while the other carbon, *b*, which has no hole, is connected to the conductor at its centre, or it may be at its edge, as shown in fig. 1. The arc then presents itself at the edge of the countersunk hole, and moves round it as the carbon consumes, or may be made to revolve round it by inductive action from a neighbouring coil or magnet. Both carbons may have central countersunk holes, as shown in fig. 2, and be connected to the conductors at their outer edges. When parallel plates of carbon are used, these plates are connected to the conductors at their opposite ends, as shown in fig. 3, the one extending beyond the other, so that the arc presents itself between the edge of the one and face of the other carbon. When two carbon plates are employed, the one plate is fixed and the other, or part of it, is set on a frame pivoted below, so that the upper edge of the movable carbon plate can approach to or recede from that of the fixed plate; the kindling of the arc and the regulation of the distance of the upper edges of the plates is effected as shown in fig. 4. In the base of the lamp an electro-magnet is fixed, the core of which is divided lengthwise into two parts, *a* and *b*, each somewhat less than a semicylinder. One of these half cores, *a*, is fixed and the other *b* is connected to the frame, *c*, of the carbon plate, which frame is pivoted at *d*. The coil surrounding the two half cores, *a* and *b*, is in the circuit of the lamp. When there is no current the weight of the frame and upper half core keeps the two half cores nearly close together, the upper edges of the two carbon plates being then in contact. When a current passes through the coil and carbons the two half cores become magnetic, and having corresponding poles next each other, the movable half core is repelled from the other, and the edges of the carbon plates being thus separated the arc is established. Should the carbons be too far apart the electro-magnet becomes weakened, allowing the half cores, *a* and *b*, and consequently the carbons to approach each other; or should the carbons be too near the electro-magnet acquires more power to cause repulsion of the half cores, and they and the carbons become consequently separated.

FIG.I.

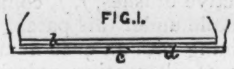


FIG.2.

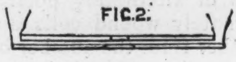


FIG.3.

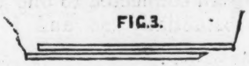
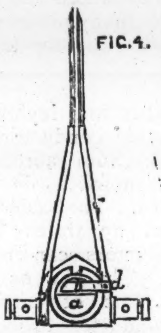


FIG.4.



1536. "Electric lamps." J. L. A. Dupont-Auberville. (A communication by Victor Delaye, of Paris.) Dated April 8. 6d. Fig. 1 shows an elevation partly in section of a lamp embodying the invention; fig. 2 shows a top view of the same; *a* is the bed or base of the lamp, upon which are erected two hollow supports, *b*, which may be moved along grooves, *c*, and set by thumb screws, *d*. Two rods carrying sockets, *e*, are introduced in supports, *b*; carbon-holders, *f*, slide in these sockets. The carbon holders may be moved horizontally or vertically by unscrewing the screws, *g*, and they may be turned or moved lengthwise by uncrewing the screw, *h*. In the carbon holders are placed the electrodes, *i*, the forward ends of which abut respectively upon abutments or blocks, *k*, made of any suitable non-conducting and refractory material. The electrodes, *i*, are pressed against their respective abutments by springs, or (as shown in the figure) by a weight, *l*, attached to cords, *q*, passing round pulleys, *s*, and acting upon rods or plungers, *m*. The electric current enters the lamp by terminals, *n* and *o*, and is passed through the electrodes by plates, *p*, provided with friction rollers, *r*. As shown in the figure the two electrodes, *s*, are parallel to one another, and their tapering extremities overlap each other. The result of this arrangement is that only the parts, *x*, *y*, of the electrodes are heated. The voltaic arc is formed between the electrodes, *i*, while the abutments, *k*, become incandescent, increasing the power of the light and imparting to it the quality and colour of sunlight. The electrodes, *i*, being permanently pressed upon the blocks, *k*, the ashes, when carbons are employed, drop away as they are produced, and thus the light is free from the variation or irregularity to which ordinary lamps are subjected, and which often produces extinction.

FIG.I.

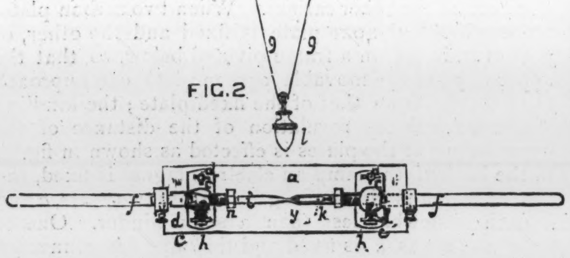
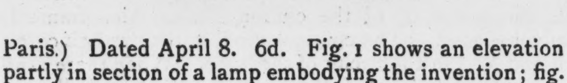


FIG.2



The following are the final quotations of stocks and shares for Nov. 18th.:—Anglo-American, Limited, 53¼-53¾; Ditto, Preferred, 81-82; Ditto, Deferred, 23¼-23¾; Brazilian Submarine, Limited, 10⅞-11⅛; Brush Light, £4 paid, 7¼-7¾; Ditto, £10 paid, 16½-17½; Electric Light, 1⅛-1⅜; Consolidated Telephone Construction, 1-1¼; Cuba, Limited, 9½-10; Cuba, Limited, 10 per cent. Preference, 16-17; Direct Spanish Limited 5¼-5¾; Direct Spanish, 10 per cent. Preference, 14½-15½; Direct United States Cable, Limited, 1877, 10¾-11¼; Debentures, 1884, 100-103; Eastern Limited, 10-10¼; Eastern 6 per cent. Preference, 12⅝-12⅞; Eastern, 6 per cent. Debentures, repayable October, 1883, 100-103; Eastern 5 per cent. Debentures, repayable August, 1887, 100-103; Eastern, 5 per cent., repayable Aug., 1899, 105-108; Eastern Extension, Australasian and China, Limited, 10¾-11; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 102-105; Ditto, registered, repayable 1900, 102-105; Ditto, 5 per cent. Debenture, 1890, 100-103; Eastern and South African, Limited, 5 per cent. Mortgage Debentures, redeemable 1900, 102-105; Ditto, ditto, to bearer, 102-105; German Union Telegraph and Trust, 10¼-10¾; Globe Telegraph and Trust, Limited, 6½-6¾; Globe, 6 per cent. Preference, 12⅜-12⅝; Great Northern, 12¼-12¾; 5 per cent. Debentures, 103-106; India Rubber Company, 24-25; Ditto, 6 per cent. Debenture, 104-108; Indo-European, Limited, 27½-28½; London Platino-Brazilian, Limited, 4-5; Mediterranean Extension, Limited, 2½-3; Mediterranean Extension, 8 per cent. Preference, 9½-10; Oriental Telephone, ¼-½; Reuter's Limited, 12-12½; Submarine, 290-300; Submarine Scrip, 2⅝-2⅞; Submarine Cables Trust, 97-100; West Coast of America, Limited, 4½-5; West India and Panama, Limited, 1⅝-1⅞; Ditto, 6 per cent. First Preference, 7½-8; Ditto, ditto, Second Preference, 6¼-6¾; Western and Brazilian, Limited, 7⅛-7⅜; Ditto, 6 per cent. Debentures "A," 110-115; Ditto, ditto, ditto, "B," 97-101; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 123-128; Ditto, 6 per cent. Sterling Bonds, 104-107; Telegraph Construction and Maintenance, Limited, 28-29; Ditto, 6 per cent. Bonds, 104-108; Ditto, Second Bonus Trust Certificates, 1⅝-1⅞.

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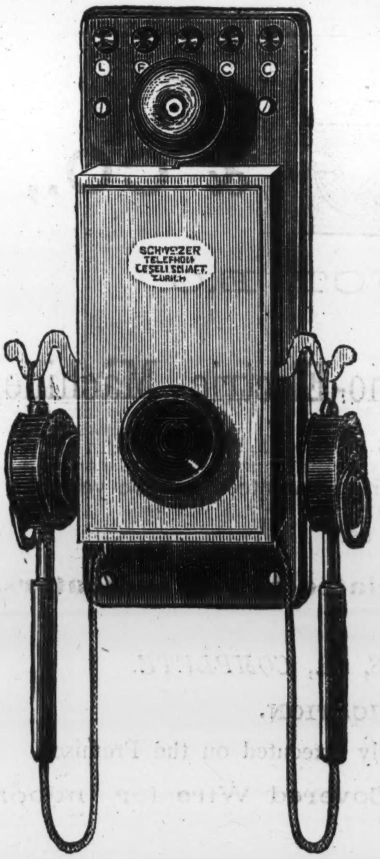

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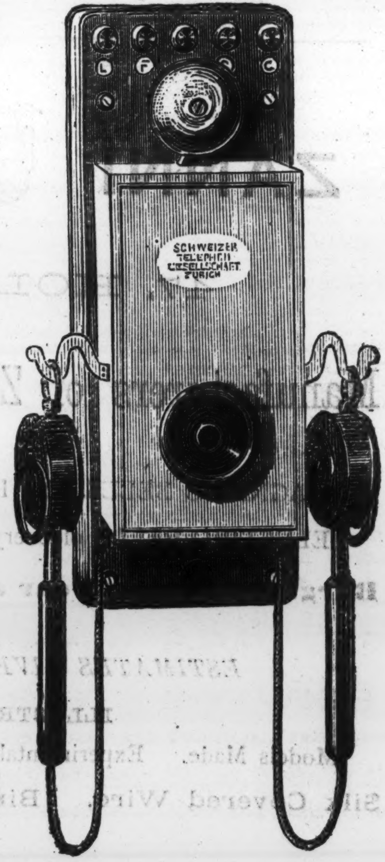

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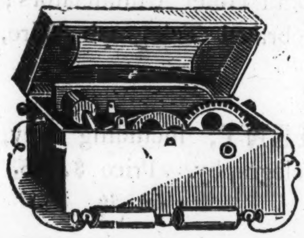

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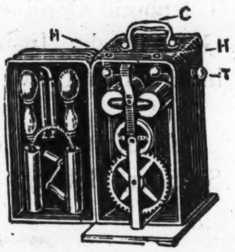

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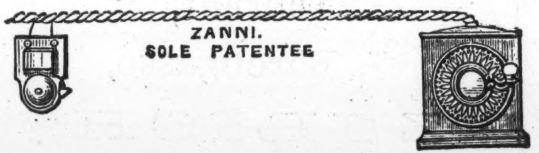

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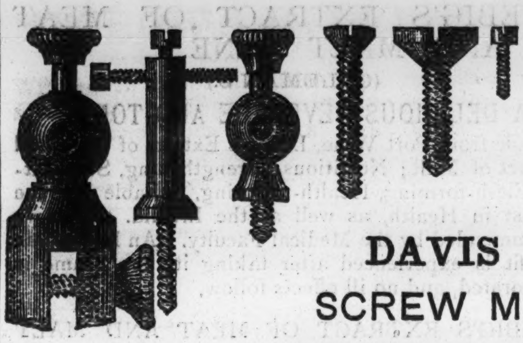

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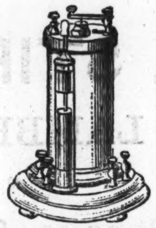

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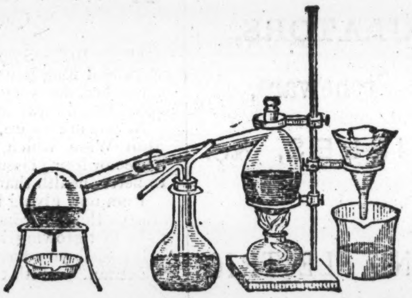

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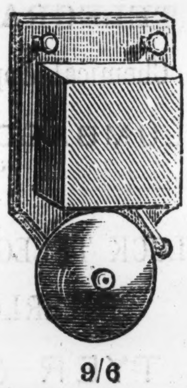

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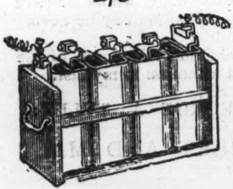

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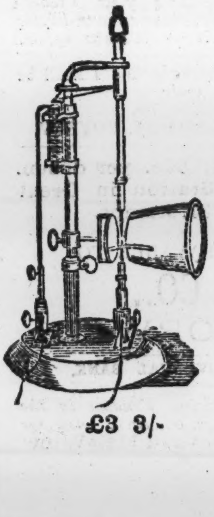

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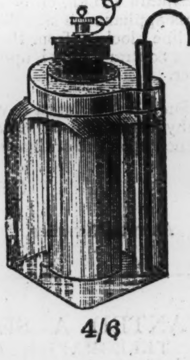

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